Materials & Methods

Where Shell Mold Castings Stand Today

New Flowed-In Synthetic Gaskets

How to Buy Aluminum Castings

Carbide Hardfacing by New Inert-Gas-Arc Method

New Glass Fiber-Filled Molding Resins

Adhesive Joining Wood-to-Steel

Metals Treated in Steam Atmospheres

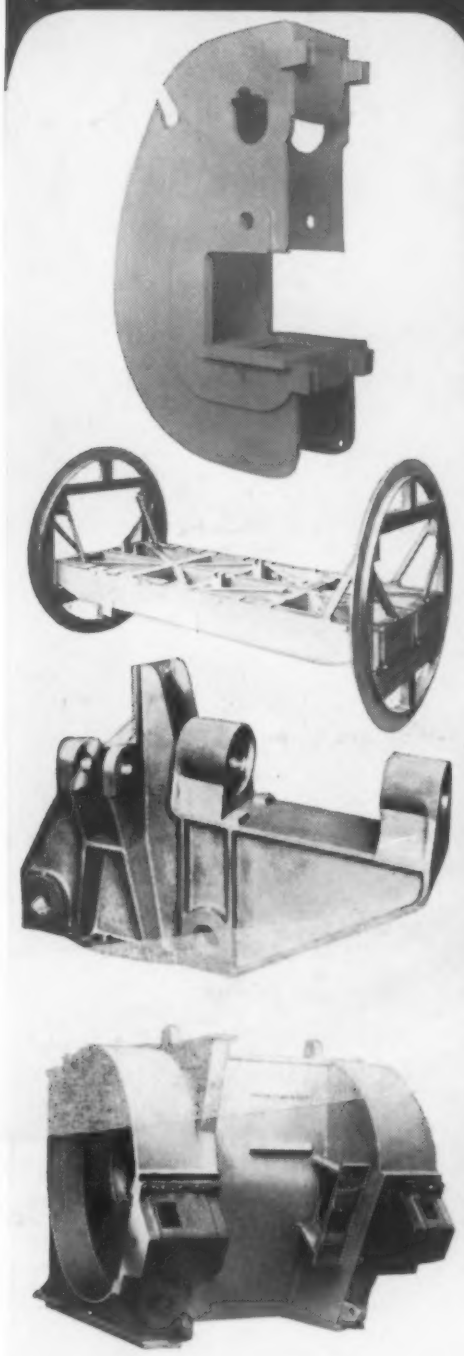
High Temperature Ceramic Coatings

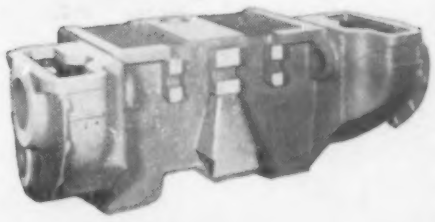
Low Expansion Nickel Alloys

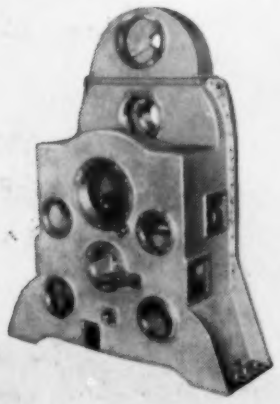
ANNUAL MATERIALS ENGINEERING REVIEW AND FORECAST
—Materials & Methods Manual No. 90

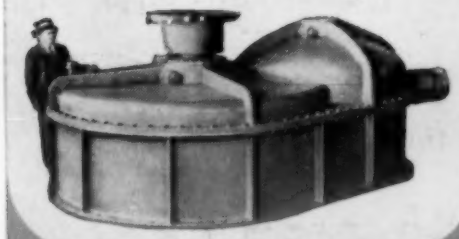
JANUARY
1953

THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

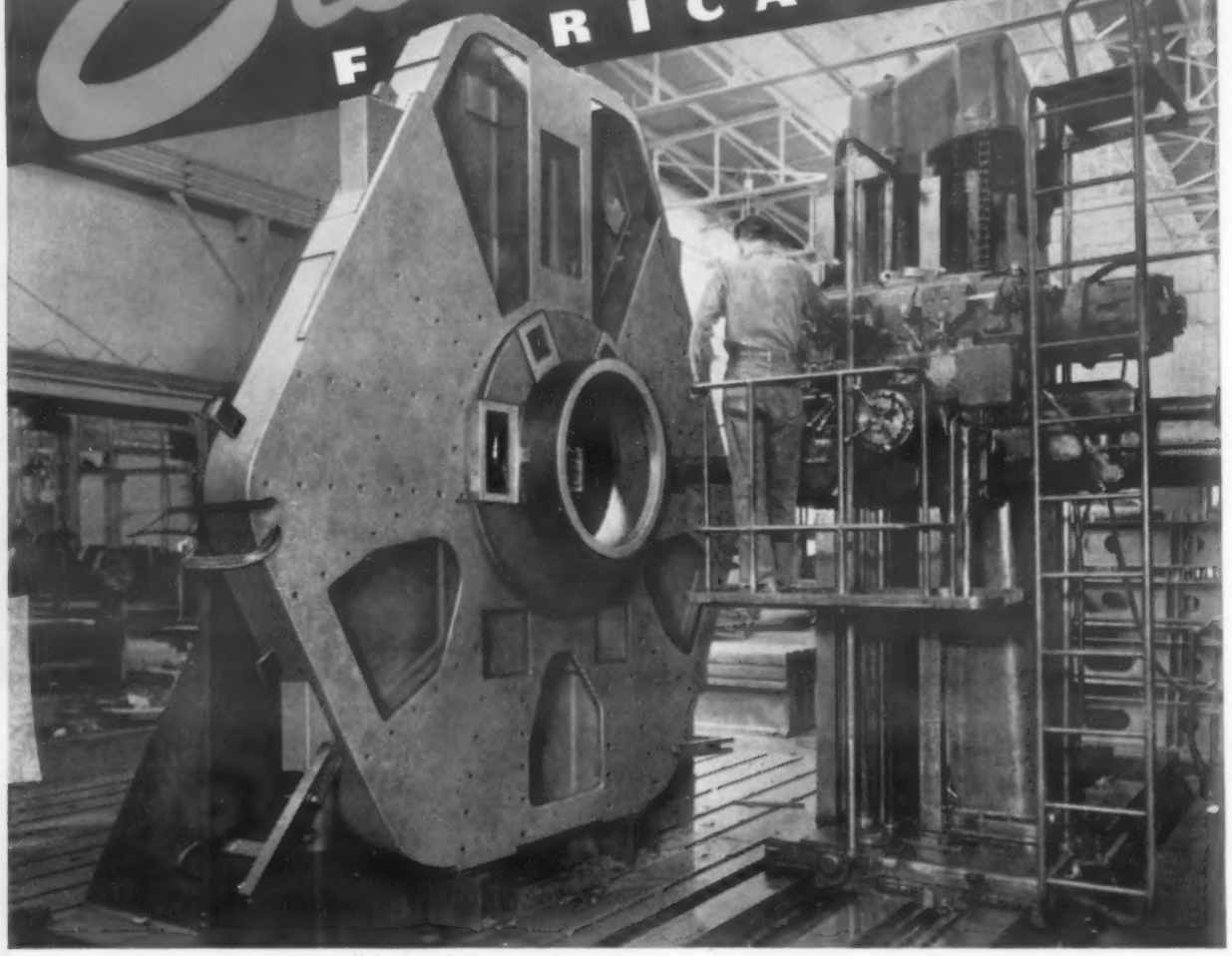








Steel-Weld FABRICATION



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Materials & Methods®

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The Materials Outlook

Glass-reinforced epoxy pipe is being made. The strength of this material is greater than that of glass-polyester, due to a better bond between the plastic and the glass. Molding is troublesome, however, due to tendency of epoxy to stick to molds.

Nodular cast iron research by the British indicates that titanium, lead, antimony, aluminum and bismuth and, in certain cases, copper, can partly or completely prevent magnesium from having the desired effect of forming nodular graphite structures. The subversive effects of these elements can be neutralized by approximately 0.005% cerium.

New nonmetallic ferromagnetic core material has been developed especially for recording heads in various types of magnetic recorders. The new material is claimed to be very homogeneous and more nearly free from voids and cracks than most commercially available ferrites.

New electrical resistance material for use in air has been developed in Sweden. Capable of withstanding 2900 to 3100 F, the alloy is expected to exert considerable influence on high temperature furnace design. It is a powder metallurgy molybdenum product. The intended applications were dental furnaces, laboratory equipment and for firing ceramic products.

Titanium has been fabricated in complex sections for helicopter exhaust shrouds. The metal is being analyzed to determine effects after several hundred hours test. Ceramic coatings on titanium are also being explored for protection against oxidation and absorption . . . . One aircraft man, incidentally, notes that engineers are beginning to believe titanium is called the "wonder metal" because it makes them wonder whether it will create more problems than it solves.

Substitutions of aluminum for copper in electrical equipment are gaining with additional experience . . . . The switch has benefits beyond copper saving in current-limiting reactors. One unit may use up to 5 tons of copper. Aluminum windings cut weight by 25%. In reactors where only separation is needed, no insulation between strands is needed to cut eddy current losses with aluminum. The natural oxide surface film is insulation enough.

Advantages of integrally-stiffened aluminum alloy forgings are illus-

(Continued on page 4)

The Materials Outlook *(continued)*

trated by the inner lower wing surface of the Constellation. With forgings, 82% of the mechanical fasteners, 62% of the sealant weight and 17% of the total part weight were eliminated.

Tolerances on large aluminum forgings made in heavy presses are controversial. One authority claims that an ideal press would produce variations of 1/8 to 3/16 in. from edge to center of a 25-in. dia pancake forging. This man claims that the only way to overcome this effect is to use trial and error to obtain properly tapered die faces to produce parts with essentially uniform sections.

All-magnesium car body has been built in England. Body, shell, doors, air ducts, gasoline tank and radiator grill are made of welded sheet magnesium. The body shell with doors weighs 140 lb.

"Navy Procurement Regulations" incorporating all current procurement rules and regulations, has been issued in one volume. Covers such subjects as contract clauses, financing, negotiation, small business, and taxes. Book is in loose-leaf form to facilitate quarterly revision. It is available at the U. S. Government Printing Office, Washington 25, D. C. Price, $3 per copy.

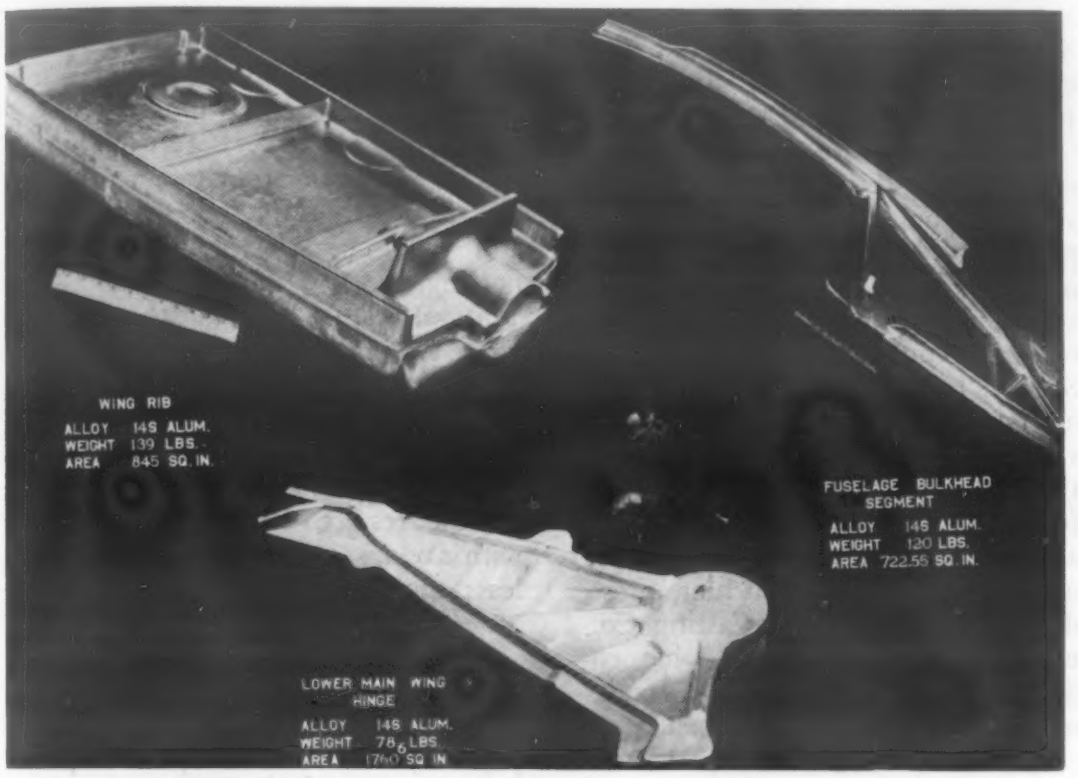
Five Aeronautical Materials Specifications on titanium have been developed. These are said to be the first specifications on the metal issued by any standardizing organization. Yield strength rather than tensile strength is used in the titles. Each specification calls for a minimum yield strength only 10,000 psi below tensile.

More nickel in crucial operating parts is carried by the new "United States" than any other passenger ship in the world.

Ways to substitute aluminum for copper in lamp bases are being investigated by Westinghouse. Because of soldering problems and the temperatures at which glass is sealed into the base, this is not easy. So far, aluminum-basing techniques have been worked out for the common medium-screw base.

Combination phenolic and silicone cement is used to seal high-wattage lamps to their bases. Phenolic, applied down in the base, hardens fast on practical lamp-basing machines to give the initial glass-to-metal seal. The silicone, slower to set than the phenolic, cures fully when the lamp is burned. The silicone keeps the seal perfect if the phenolic weakens under operating heat.

Nylon moldings are used in more than 800 applications. Business machine counting dials, ratchets, solderless electrical connectors, switch parts, cord connectors, fuse holders, tail lamp plugs and a variety of insulating grommets and sleeves for electrical units are being made of nylon.



Some typical large aluminum forgings now being produced.

Heavy Press Program Pushed for Forged Aircraft Parts

Big Aluminum Forgings Have Advantages of Low Cost, Strength and Light Weight

Present Status of Press Procurement

Press and Capacity	Operator	Builder
50,000 tons forging	Wyman-Gordon	Loewy-Hydropress
35,000 tons forging	Wyman-Gordon	Loewy-Hydropress
35,000 tons forging	Alcoa	United
50,000 tons forging	Alcoa	Mesta
25,000 tons forging	Harvey	Baldwin
35,000 tons forging	Harvey	United
25,000 tons forging	Kaiser	Bliss
35,000 tons forging	Kaiser	Bliss
12,000 tons extrusion	Alcoa	Schloemann
20,000 tons extrusion	Alcoa	Loewy-Hydropress
12,000 tons extrusion	Curtiss-Wright	Loewy-Hydropress
8,000 tons extrusion	Harvey	Loewy-Hydropress
20,000 tons extrusion	Harvey	United
8,000 tons extrusion	Kaiser	Loewy-Hydropress
8,000 tons extrusion	Reynolds	Loewy-Hydropress
12,000 tons extrusion	Reynolds	Lombard
75,000 tons forging	—	Loewy-Hydropress
25,000 tons extrusion	—	(engineering only)

Facts and figures on the U. S. Air Force heavy press program were given out at a recent press conference held at the Wyman-Gordon Co., North Gafton, Mass., plant. The largest press outside Russian-controlled countries, an 18,000-ton press made by the Mesta Machine Co., was shown in operation. Models of 35,000- and 50,000-ton presses and supporting heat treating and handling equipment, under construction for Wyman-Gordon use, were on display.

The heavy press program started during the last war. The 18,000-ton press was built in 1944. The original plan was to concentrate on magnesium forgings. Magnesium did not respond well to hammer forging, but worked adequately under the slower movement of the hydraulic press. The fatigue strengths of magnesium alloys were not as high as aircraft designers wished, however. With the development of 75-S high strength aluminum alloy (also difficult to hammer forge), the 18,000-ton press was turned to aluminum.

With the experience gained during and after the last war in this country and Germany, it was recognized that forged and extruded aluminum parts held great promise for aircraft. Under the sponsorship of the U. S. Air Force, a balanced program of development for large presses was begun. The accompanying table lists the 17 presses now planned. The field of application seems limited to aircraft, for the present at least, and private companies could not economically invest the required capital. For this reason the presses will be owned by the Air Force and operated by the companies listed.

The big advantages of aluminum forgings and extrusions are low cost, strength and light weight. Complex shapes can be forged and extruded cheaper than they can be fabricated from simple components. Castings are acceptible from the complexity angle but strength is lower and weight greater. The advantages of forgings and extrusions increase as the sizes available grow. Hence, larger presses are scheduled.

(*Continued on page 8*)

News Digest

The projected forging presses can conceivably handle steel. There will be limitations, however. Aluminum and magnesium forge at 800 to 850 F. Dies heated to 400 F give acceptable performance. Steel at 2200 F would cool rapidly and could not be pushed into as thin sections as the light metals. With the perfection of techniques, however, steel press forges will undoubtedly be developed further.

Materials & Methods Editor Named Materials Conference Chairman

T. C. Du Mond, Editor of MATERIALS & METHODS, has been appointed chairman of the Conference on Basic Materials for Industry, which will be held in conjunction with the First Exposition of Basic Materials for Industry in New York City, June 15-19.

The Conference sessions will be held June 16, 17 and 18 at the Hotel Roosevelt, and will be aimed at providing information to help engineers, designers, materials engineers and other technical personnel in the selection and application of engineering materials.

A group of prominent men is now being recruited from the product manufacturing industries to serve as an advisory committee on the program. Suggestions on topics to be covered at the Materials Conference are invited for consideration by the advisory committee. They should be sent to T. C. Du Mond, c/o MATERIALS & METHODS, 330 West 42nd St., New York 36, N. Y.

Product Development Program Stresses Conversion to Steel Castings

Lower Price Is Big Advantage

Continuing advances in product engineering and expansion of research were emphasized at the recent Seventh Annual Technical and Operating Conference of the Steel Founders' Society of America.

Ross L. Gilmore, president, Superior Steel & Malleable Castings Co., summed up product development progress. Mr. Gilmore reported on initial findings in a preliminary survey conducted in 81 foundries in six of eight geographical divisions of the Society. In a period of 18 months, a minimum of 1035 engineering conversions to steel castings had been fostered and carried out in the foundries covered. The conversion added more than 41,000 net tons of new work. Allen M. Slichter, president, The Pelton Steel Casting Co., emphasized that company-wide cooperative interest and action is fundamental to product development.

With relatively small parts, experimental patterns are a sound investment, Mr. Slichter said. The Pelton practice is to make an inexpensive experimental pattern, produce a few sample castings, and submit for customer acceptance the suggested conversion castings with complete data on costs, weight, etc.

In the great majority of cases, price advantages offered by steel castings proved to be decisive. Improved appearance also is an important contributing factor, he pointed out—"but most of all, it's a case of arithmetic; the matter of comparative saving is conclusive."

R. B. Cottrell, Sr., chief mechanical engineer, American Steel Foundries, said service conditions are just as important in redesigning a casting as in original designing. With service data, the design engineer should be able to decide if the original design is suitable for service requirements, and if modifications may be made to improve it, reduce weight or expense of manufacture.

"Casting Simplification" was the subject of a paper prepared by Carl F. Haertel, foundry superintendent; and Emil Martinek, product development engineer, The Falk Corp.

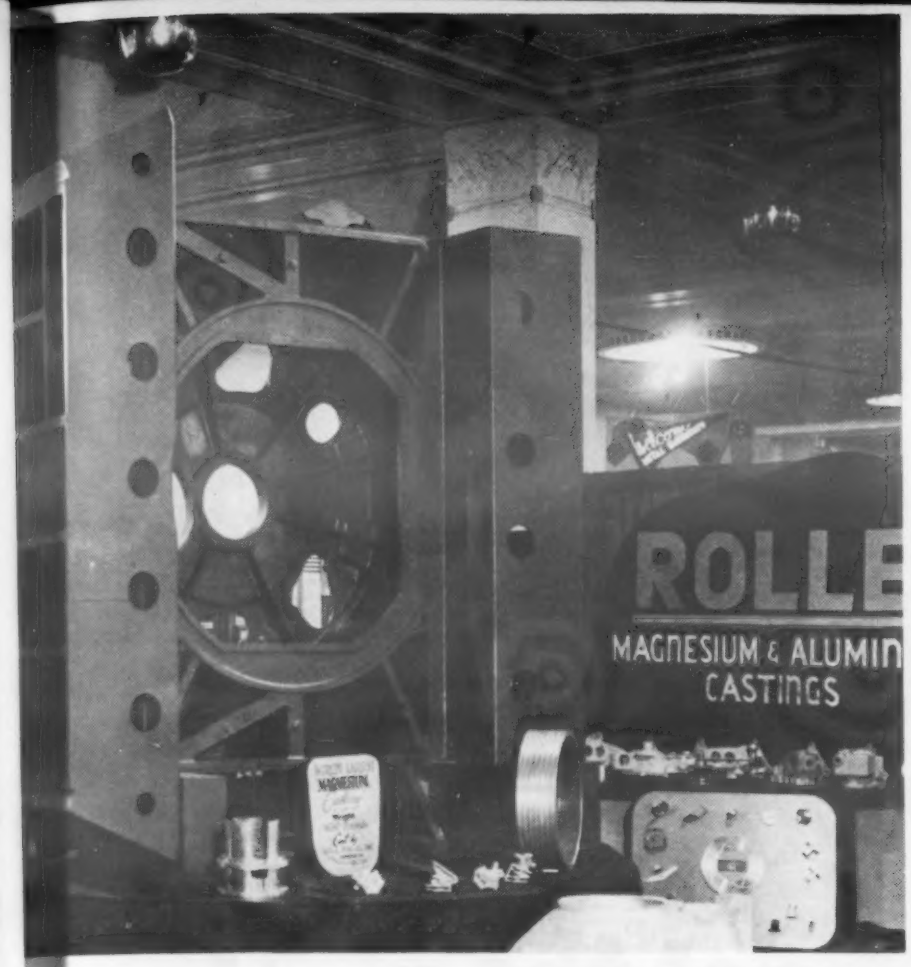
In the case of a large main frame casting for crusher service, casting simplification enabled the company to step-up production while effecting economies. The answer was rearrangement of original pattern equipment, without change in basic design, and a simpler method of molding and core making to cut down man-hours on the job and produce quality castings. Cost factors were appreciable, the number of cores being reduced 69%; molding, 40%; cleaning and welding, 28%; metal and annealing, 3%.

Simplification applied to another large casting, a 17,000-lb feed end head for a mill, also subject to quantity delivery requirements and produced in the large foundry where backlog was heaviest, brought comparable results, Mr. Martinek said, with savings as follows: cores, 82% less; molding, 23% less; cleaning, 50% less; metal, 14% less.

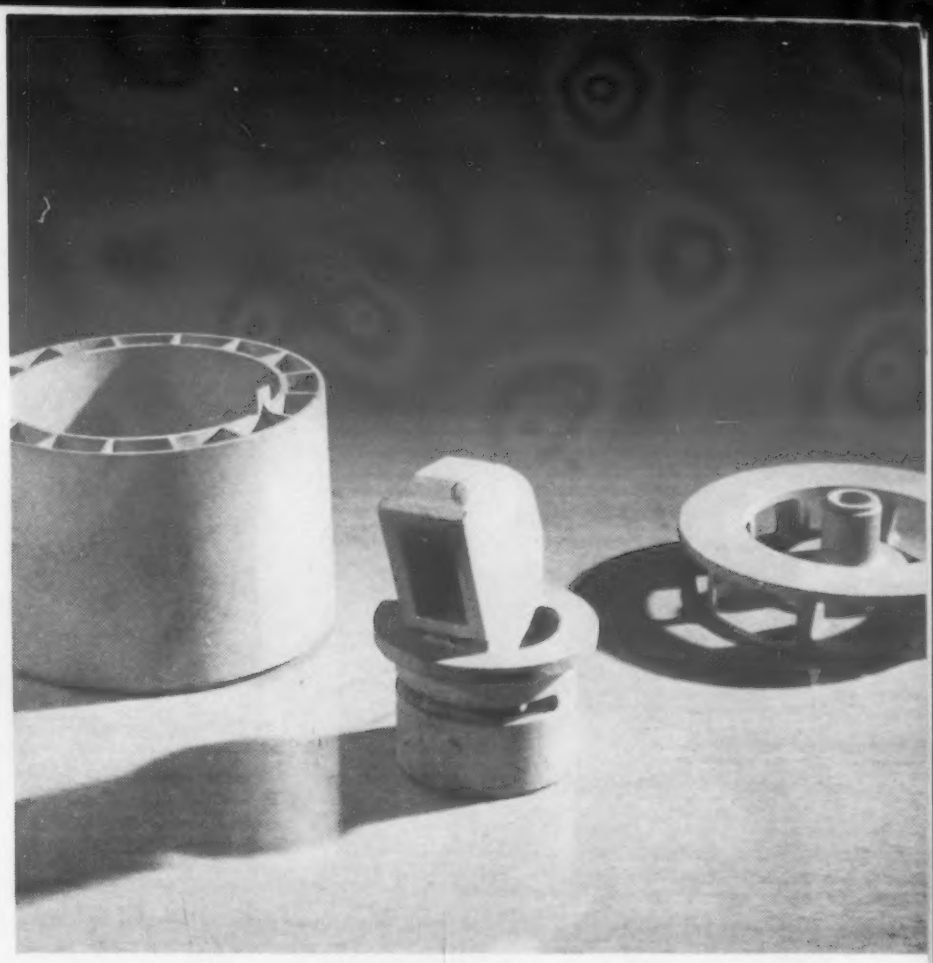
Details of study and experience in use of the cast-weld method of construction were incorporated in a paper by H. E. Edsall, plant superintendent, and F. E. Browne, service and welding engineer, Birdsboro Armorcast, Inc., subsidiary of Birdsboro Steel Foundry & Machine Co.

By practical application of this process—improving certain complicated castings by molding and pouring them in several separate pieces, each of a simple shape, and then welding the component parts together—a number of desirable advantages may be realized, Mr. Edsall reported. Among these he listed (1) lower pattern costs; (2) lower machining costs through closer adherence to finish dimensions; (3) improved damping properties as compared with all-plate or structural shape fabrication; (4) lower final cost through simplification of design; (5) better service from foundry with employment if simpler techniques; and (6) customer acceptance.

The cast-weld principle however, should not be considered as a cure-all for all unprofitable or extremely intricate foundry work, Mr. Edsall cautioned. Until ample experience with the process has been gained, thorough cost studies should precede any possible breakdown of an integral unit for cast-weld procedure. In some cases, it has been found that breaking down a casting into two or more component parts and welding can be far more expensive.



Largest magnesium casting ever made, produced by Rolle Manufacturing Co., was exhibited at the 1952 Metals Show.



Magnesium precision castings are now being produced commercially for optical, aircraft and other applications by Arwood Precision Casting Corp.

Recent Developments Open New Fields for Magnesium Castings

Unconventional Applications Point to Future Uses

Magnesium castings are becoming (1) larger, (2) thinner, and (3) smaller. Recent development work also indicates that magnesium castings may often be stronger and more dependable than they have been thought to be. On the production side, new casting techniques are being used, primarily to get closer tolerances and better surface finishes.

There are the points that impressed spectators who attended the casting technical session at the Magnesium Association meeting. Many developments are still in pilot-plant stages and others are presently used only in military products. Nevertheless, some of these unconventional magnesium parts undoubtedly cast shadows for the future.

Magnesium castings are now being made in shell molds. Closer tolerances, better finish and reduced machining are outstanding advantages. Scrap losses are, of course, reduced, since less risers, chills and gates are necessary and because hard, easy-to-handle shell molds do not break or crumble easily. Production per man-hour is increased and skilled labor is not required. Storage problems of space and mold water absorption are also reduced. Only a few different types of castings have been made so far, and the size and nature of castings for which shell molding can be used are somewhat limited at present. No extensive cost figures are available yet, but producers feel sure that substantial savings can be made with

(*Continued on page 11*)

Estimated National Consumption of Magnesium in 1951 by Fields of Application or Use

Aircraft: engines, wheels, airframes, etc.	29.3%
Aluminum Industry	20.4
Electrochemical Uses: underground anodes, fresh water anodes, sea water anodes, etc.	8.5
Ground Transportation: trucks & trailers, automotive, etc.	7.6
Machinery & Tools: portable tools, business machines, etc.	6.2
Chemical & Metallurgical Uses	6.0
Materials Handling: dockboards & skids, foundry equipment, concrete industry, etc.	4.7
Electrical Equipment: Radar, radio, TV, etc.	3.5
Magnesium Powder	2.4
Consumer Products: ladders & hand tools, furniture, sporting goods, etc.	1.6
Textile Industry	0.8
Printing & Engraving	0.4
Unclassified or Miscellaneous	8.6
Total	100.0%

NOTES:

1—Above includes metal in the forms used by the particular industry. Thus, as rough castings, sheet, etc. used in the aircraft industry; not primary and secondary magnesium used to produce these forms.

2—No metal going to stockpile is included.

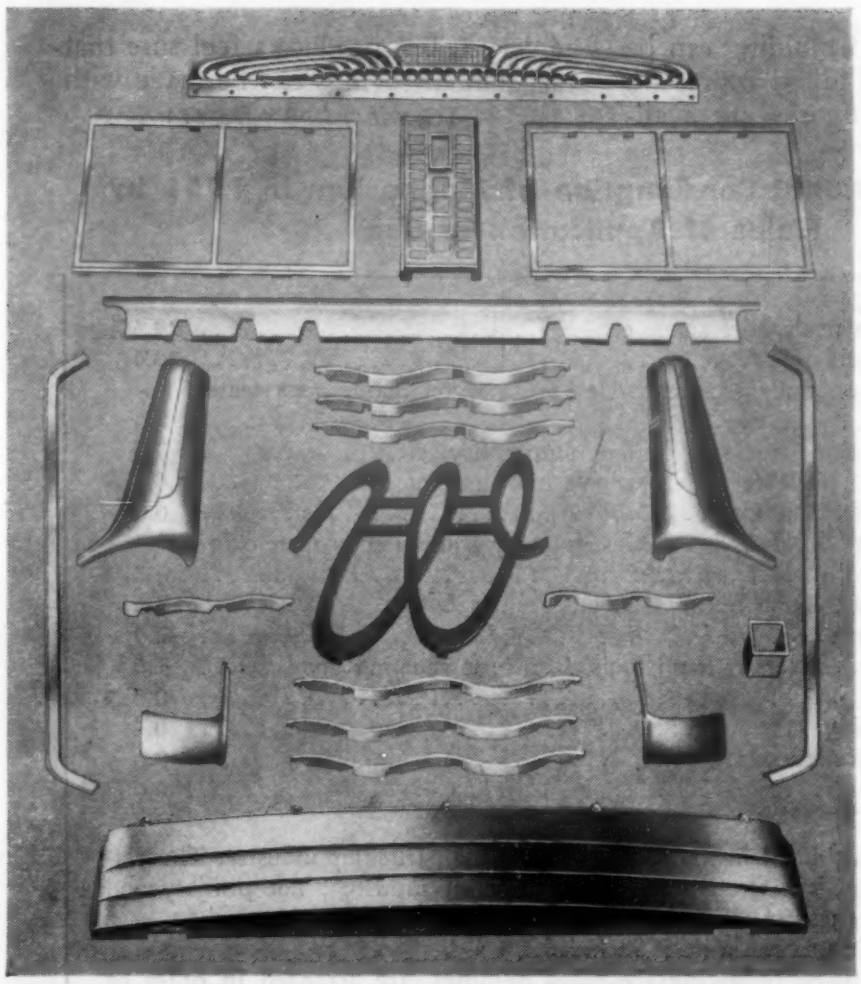
3—The detailed uses, following the main headings, are arranged in order of their estimated position.

4—Total magnesium consumption 1951 was approximately 100 million lb (exclusive of stockpile). So, by coincidence, the percentage figures approximate the amounts in millions of lb.

Compiled by The Magnesium Association

take a cue from the

WURLITZER 1500 -get the mo$t for your Zinc Die Ca$ting Dollar!



Your design and production problems may be far removed from those entailed in the engineering of a coin-operated phonograph, but the use of ZINC Die Castings in styling the new Wurlitzer 1500 model might well be your cue to important manufacturing economies.

Glance at any one of the phonograph trim castings pictured here and ask yourself how else it could be produced in the required shape, with close tolerances, with clean-cut reproduction of detail and with a surface which could be electroplated or painted at low cost. In many instances, these pieces have dimensionally accurate cast mounting elements and cored openings which mean that an absolute minimum of secondary operations are needed to prepare the castings for close-fitting assembly.

In ZINC Die Casting, the Wurlitzer engineers long ago found a metal and method of fabrication which offers complete freedom of design with impressive production savings. If *you* are not fully aware of the physical and economic advantages of ZINC Die Castings in product engineering it is suggested that you contact any commercial die casting company—or write to us.

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

News Digest

(continued from page 9)

many finished products. In any case, commercial orders can now be taken for magnesium parts cast by the shell molding process.

Close tolerances and good surface finish are also featured in precision investment castings now being made of magnesium. There have not been many commercial applications, yet. The field is new, however, and more uses are expected. Considerable trouble was experienced with this process in the beginning, but sound-castings can now be poured in production quantities. In the beginning, the metal would explode and blow out of the flask or burn spectacularly. It was found that the molten metal tended to react with the investment material (silica and plaster). In some cases, castings looked good superficially but were filled with internal oxidation flaws. The addition of a nonvolatile inhibiting compound to the investment mixture and development of a method to remove oxygen from the flask after burnout solved the problem.

At the other end of the scale are the extremely large magnesium sand castings now being made. Some of these are outstanding by shear size. The largest one so far is a radar equipment piece, designed for air transport. Weight reductions will obviously be the primary reason for choosing magnesium for castings of this size. The good machinability is an additional advantage in many parts. Magnesium is also highly castable and runs in comparatively thin and complicated sections. Some thought has been given to casting large machine housings in magnesium.

Some of the most interesting large magnesium castings are being made for the airframe industry. These are complicated units, with thin walls. For example, a riveted 0.051-in. aluminum sheet assembly may be replaced by a magnesium casting with 0.1-in. walls with no increase in weight. The weight of lap joints, rivets and stiffeners in fabricated units balances the weight of additional wall thickness in replacement castings. It also seems to be true that the mechanical properties of casting alloys increase as the cross section decreases. In aircraft production quantities, castings often hold production advantages over fabricated units. Airplane duct tubes, carburetor air scoops, moving window frames,

(*Continued on page 158*)

Neoprene's outstanding properties

HEAT RESISTANCE

ABRASION RESISTANCE

OIL RESISTANCE

These properties of neoprene increased the efficiency of this

CONTACT WHEEL

The serrated neoprene surface of this new type of contact wheel for abrasive belt applications means longer belt life, faster stock removal, and more uniform finishing. The flexing action of the resilient face constantly varies the grinding angle of the abrasive particles . . . thus reduces "glazing," enemy of long and productive belt service.

Neoprene does not soften or weaken from high frictional heat . . . resists abrasion, cutting and chipping. What's more, it withstands attack from grease and oils.

The Carborundum Company, Niagara Falls, New York

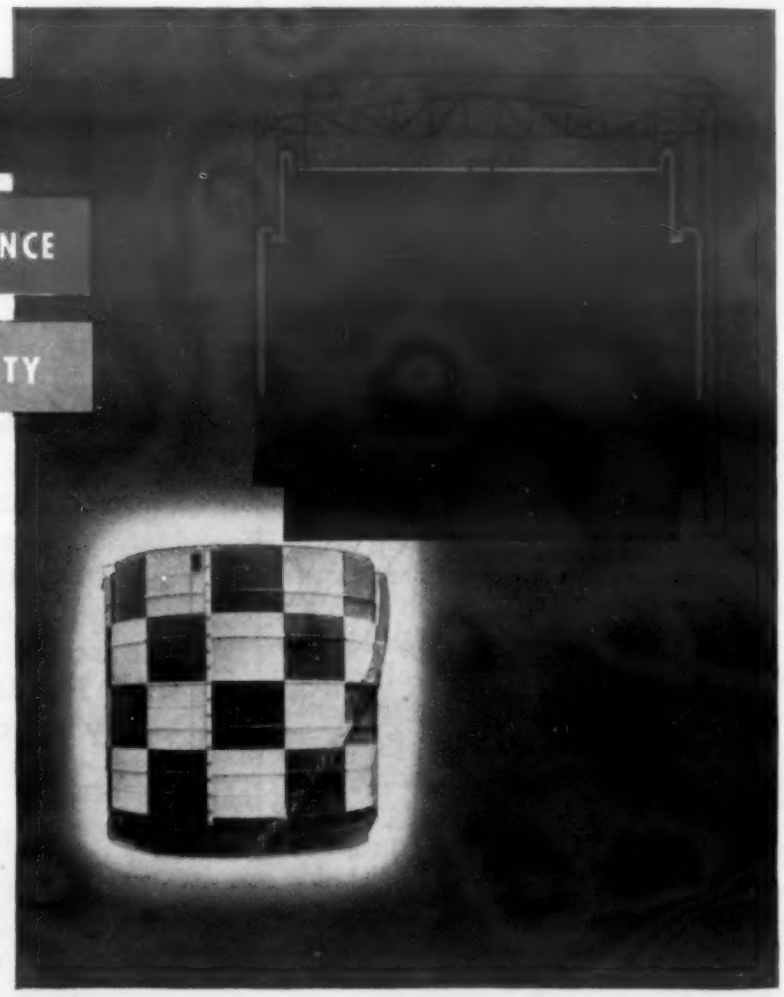
These properties of neoprene lengthened the service life of this

GASHOLDER

FLEXIBILITY

CHEMICAL RESISTANCE

LOW PERMEABILITY



A cover of woven asbestos coated with neoprene acts as a "dry seal" in this gasholder for the storage of petroleum vapors, and chemical process and industrial gases. As gas is fed into the gasholder and the frictionless floating piston rises, the flexible seal rolls off the telescoping fenders and onto the outer shell.

Neoprene is an excellent coating material because of its low permeability, resistance to chemical attack and long-lasting flexibility.

General American Transportation Corp., Chicago, Ill.

Materials & Methods
January 1953

Excellent surface finish and good dimensional accuracy are leading to increased applications of shell mold castings in a growing list of industries. (TruCast Co. and Durez Plastics & Chemical Corp.)

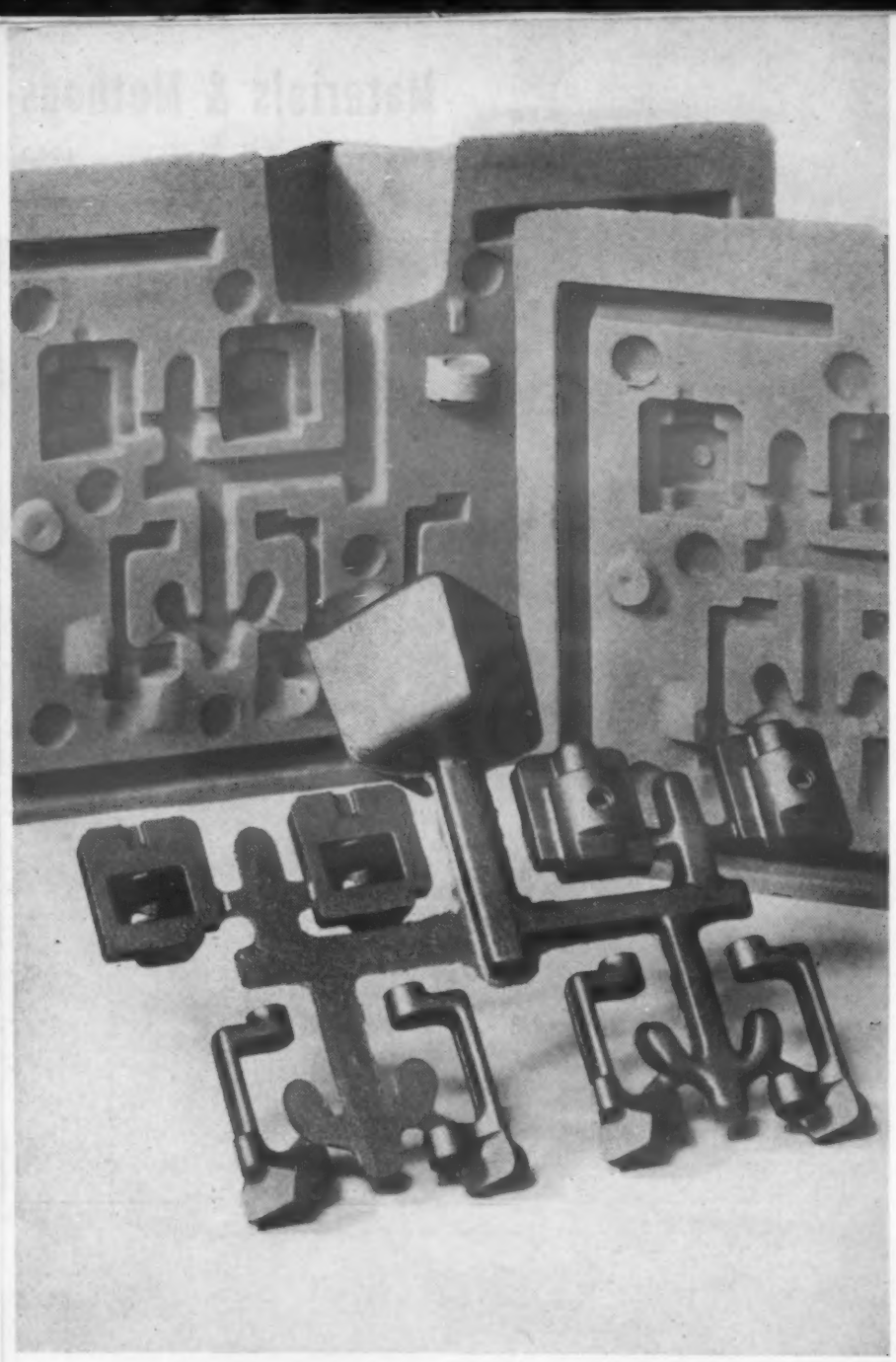
Where Shell Mold Castings Stand Today

by **KENNETH ROSE**, Mid-Western Editor, Materials & Methods

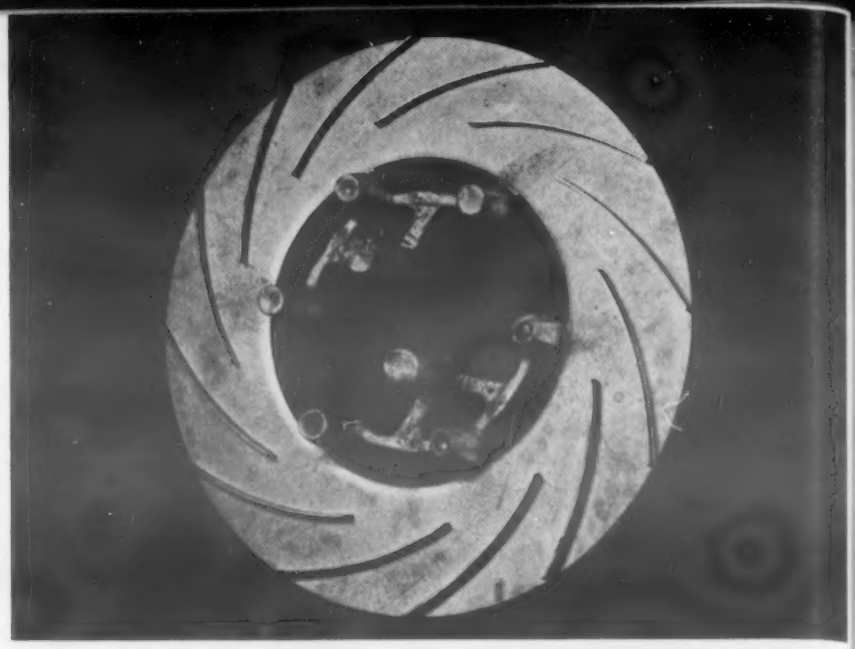
Here are specific cost figures and an appraisal of the properties of castings produced by the much-talked-about "C" process.

● AT THE END OF World War II, American technical teams, searching through German industry for materials and technical methods that could be brought to America, found a casting method (or more accurately, a molding method) that had been in rather wide wartime use in Germany. The method was referred to as the Croning or "C" process, and its characteristics as well as those of castings made by the process were described in MATERIALS & METHODS several years ago (August 1950). Since then, the term "shell molding" has received general acceptance.

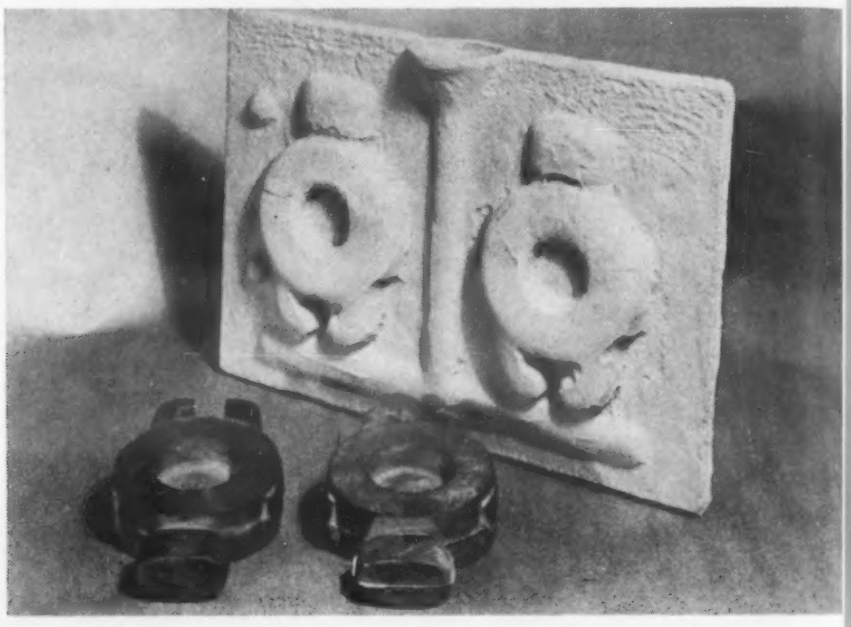
As with many new developments, the potentialities of shell molding and of the resulting castings were difficult to assay when the first announcements were made, and some sweeping statements were made of the place it would take in the casting field. The process has been in use experimentally and as a production method for several years and its place is now better defined. The engineer can now study the process and its end products against a background of facts that have developed



GRAY IRON CASTINGS produced by the Production Pattern and Foundry Co. show excellent surface finish obtainable. (Monsanto Chemical Corp.)



ALUMINUM TURBINE DIFFUSER, 32½-in. dia, was produced by shell molding in 75% less time than had been required by sand casting. (Durez Plastics & Chemicals Corp.)



BRONZE VALVE PLUGS produced by Chapman Valve Co. (Monsanto Chemical Corp.)

during its use in production foundries for a sufficient time to bring out its advantages and disadvantages.

Fundamentally, shell molding is an extension of the American use of resinous core binders, and the same resins are used. It consists of making thin shells of resin-bonded sand over a hot metal pattern, baking the shells to complete the cure of the resin, and of casting metals in these shell molds. Some of the most important advantages are: (1) excellent surface finish of the cast metal; (2) high dimensional accuracy; (3) possibility of reduction in scrap losses; (4) adaptable to a wide range of metals; (5) adaptable to mechanization, and to high production; and (6) smaller amount of material, mostly sand, to be handled in the foundry.

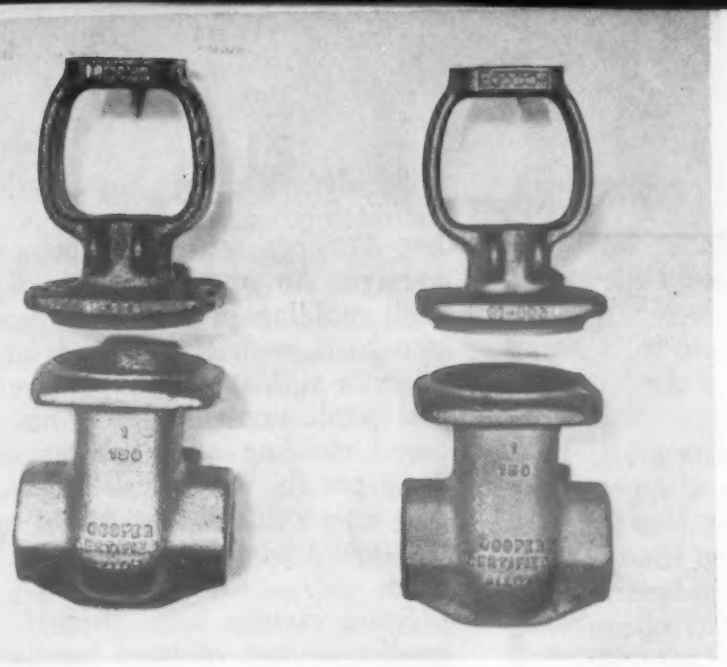
The principal disadvantages of shell molding may be stated briefly as follows: (1) high cost of the material, pattern equipment and machines; (2) sand is not re-usable under most conditions; (3) because of high initial costs, suitable only for large volume work.

Properties of Castings

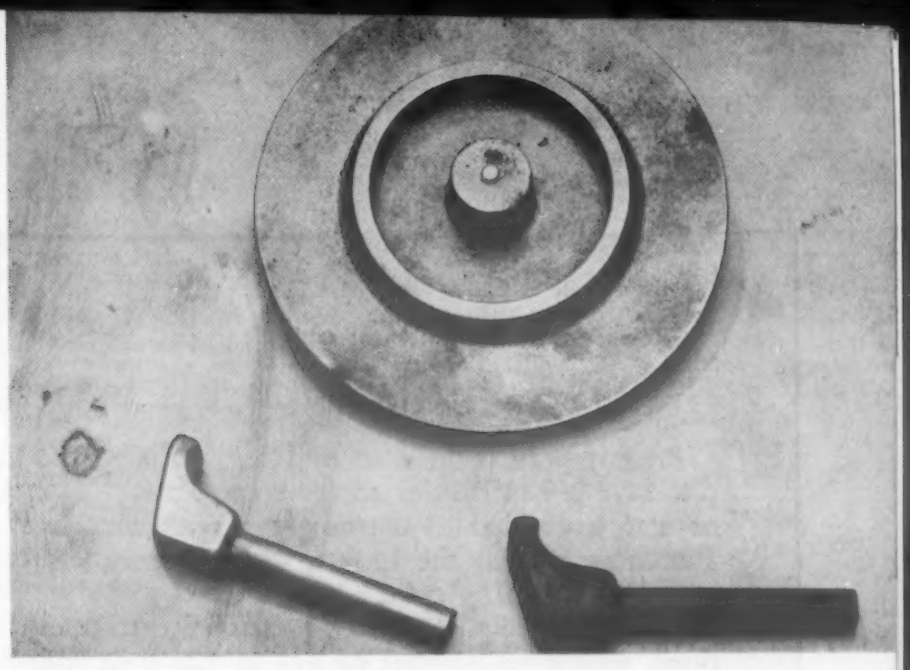
Surface quality and high dimensional accuracy are the most important positive features of shell mold castings. It is upon these advantages that the method must stand or fall in industry. Dr. Robert F. Thomson, of General Motors Research Laboratories, and others have stated that shell mold castings must pay their way with savings made outside the foundry—that is, savings in machining or other processing must be made to justify the higher costs in casting. The combination of close dimensional tolerances and good quality of cast surface sometimes makes it possible to eliminate a machining operation where the surface in question is not subject to running friction against another surface.

Another leader in the foundry industry points out that while the finish obtained is good, it is "not good enough", for it cannot meet the requirements for a machined running surface, and if the surface must be machined it is no more difficult to remove 0.030 in. than 0.005 in. Where a smooth surface is desired, but actual running over another surface is not necessary, the fine cast surface obtained in the shell molding process will usually be satisfactory, however. One nonferrous foundry is using the method solely upon the basis of the better surface obtained, without regard to greater dimensional accuracy. The surface is no better than that obtainable with precision investment casting.

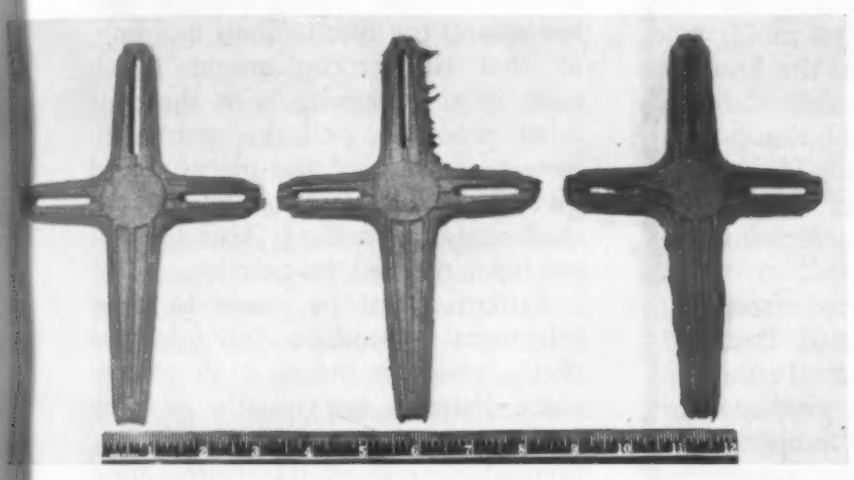
The matter of dimensional accuracy possible and practicable with shell molding has been overstated,



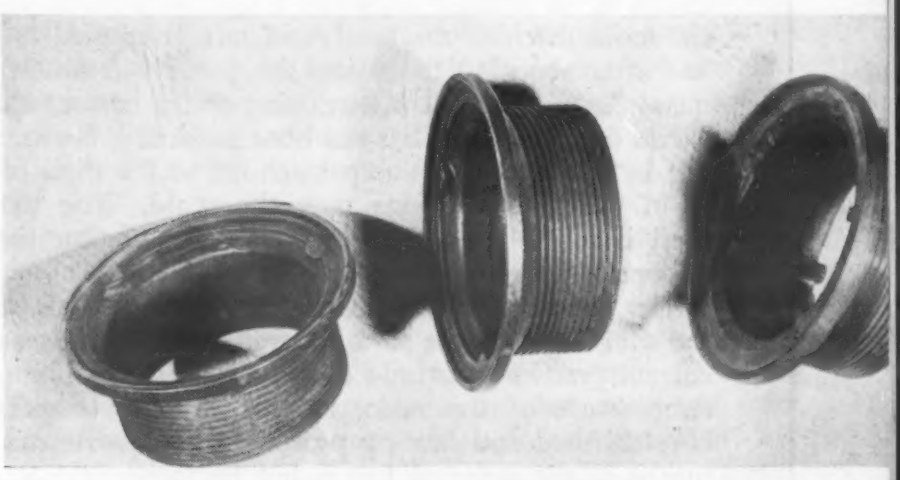
STAINLESS STEEL VALVE PARTS produced by sand casting (left) and shell molding (right.) The improved surface appearance of the latter is evident. (Cooper Alloy Foundry Co.)



MALLEABLE IRON AND MANGANESE BRONZE clamps shell molded by TruCast Co. are close enough to size to be thread-chased without a preliminary box-tool operation. Converting cast iron disk from sand casting to shell molding saved four turning operations. (Durez Plastics & Chemical Corp.)



MAGNESIUM HUB SECTION of a dial scale indicator produced by shell molding (left and center) for Howe Scale Co. Improvement in surface quality is indicated by comparison with casting produced in a conventional sand mold (right). (Utica Radiator Corp.)



NICKEL-SILVER FLOOR DRAIN made by shell molding by TruCast Co. for J. A. Zurn Manufacturing Co. eliminated five machining operations necessary with sand casting. Threads on the shell molded part were sufficiently accurate to require no subsequent thread-chasing. (Durez Plastics & Chemicals Corp.)

according to most foundrymen using the process on a production basis. Tolerances of 0.002 in. per in. cannot be guaranteed on a production run in the foundry, even though they may be obtainable in the laboratory. Foundry engineers using the process state that about the best tolerances they can hold are ± 0.003 to ± 0.005 in. per in. inside the shell, and perhaps twice that across the parting line.

The possibility of reduction of losses from rejects is closely tied with surface finish or dimensional accuracy, but may be a factor in itself also. A foundryman casting gray iron by shell molding stated that his scrap loss fell from an original 12% to only 1% after adoption of the method.

So far, the practical applications of shell molding have been in the field of small parts of close tolerance, and the size limits have not been determined. The limiting size is probably dependent upon the relationship between temperature of the hot metal and destruction of the resinous bond in the sand. The sand falls away from the cast piece readily, indicating that the bond has been destroyed practically in its entirety. This suggests that the limiting size of casting is reached when the heat in the cast metal will destroy the bond before the metal has solidified, and the shell mold will fail.

Shell molding is a mechanized process, and there are several machines on the market that will produce good work consistently with only semiskilled operators. This makes for high production. While actual production rates will depend upon a number of factors, from about 20 to 80 sets of shells per hr can be expected under most conditions. It must be pointed out that even faster production can be obtained from a good jolt-rollover machine, but of course without the same quality in surface or dimensional accuracy in the casting.

Cost Considerations

The matter of cost of the process hinges upon the cost of the resin, according to most engineers who have studied it. The resin used as a binder for the sand costs about 33¢ a lb. The amount needed varies, but will range between 5 and 12%, with 7% of the weight of the prepared sand a good general average. Other ingredients are needed also, such as a release agent to permit the shells to be removed from the patterns without difficulty, sometimes an inhibitor in the mixture, and a catalyst and accelerator if these ingredients are not a part of the formulated resin. Sand cost will vary with location and type of sand used,

How Shell Mold Castings Are Made

Present practice in shell molding, utilizing the experience and cost saving possibilities so far accumulated, is reaching a degree of standardization. Patterns are precision-made of cast iron or aluminum, usually the former, and it is necessary to have enough to fill the molding cycle, along with as many patterns in reserve as conditions require. The patterns are preheated to start operations, with a temperature of 375 to 425 F or slightly higher considered good practice. After the first cycle the patterns remain hot, and no separate preheating operation is necessary.

The heated patterns go to the molding machine, usually on some sort of conveyor. If a mold release agent is not incorporated into the sand-resin mix, it is applied to the pattern before the mix covers it. A silicone liquid or a wax preparation can be used. In the mold machine the sand-resin mix is applied to the hot mold, and after about 10 to 30 sec, the portion in contact with the hot metal "sets", due to the hardening of the hermosetting resin. The excess of mix, which has not been hardened, is removed by dumping in the case of a dump machine, and a shell of about ¼- to ⅜-in. thickness remains over the mold. The thickness of the shell is controlled largely by the length of time the mix remains in contact with the hot pattern.

The pattern with its coating of sand-resin is conveyed from the molding machine into an oven where cure is completed. Best current practice is to hold oven temperature well above actual cure temperature of the resin, so that a steep temperature gradient is established and heating proceeds quickly. Actual cure temperature is of the order of 300 F, but furnace temperatures may range from 800 to 1200 F. Cure will be completed within about 2½ to 3½ min. The shells are then stripped from the patterns, and the hot patterns are immediately recycled to the molding machine. The shells are then ready to be joined into the shell mold.

Methods of joining the halves of the shells include (1) rigid backup, in which the halves are pressed together by a clamping device that matches in contour the exteriors of the shells; (2) spring-loaded backup, in which the backup pieces are pressed together by springs; (3) green sand backup; (4) dry sand backup; (5) shot backup; and (6) pasting, in which the halves of the shell are joined together by a resinous adhesive.

Ford Motor Co., with an excellent shell molding operation, uses shot backing for the shells. General Motors Central Foundry Div. uses paste joining, while General Motors Fabricast Div. uses clamping and rigid backup.

Procedure for joining is routine, except for the paste technique. Here the halves of the mold are paired after stripping from pattern, with the cope shell first being coated with a resinous adhesive over the parting line outside of the mold cavity. The adhesive may be applied by dipping. The halves are clamped, and heat in the shells cures the resin in the adhesive. The shell mold is ready to be poured after 30 to 40 sec.

Pouring temperatures for the steels, cast irons and aluminum are the same for shell casting as for conventional foundry practice. About 12 to 15 min later the pieces are shaken out, and processing is complete. With aluminum and white or gray cast iron, the cast pieces shake free of sand without any burn-in. With steels, especially the alloy steels of slightly higher melting point, there seems to be some tendncy to burn in sand, or to develop a small amount of skin porosity.

but $10 per ton might be a fair average. An important user of the shell molding process on a production basis, with several years of experience with it both experimentally and production-wise, gives his prepared molding sand cost at about 3¼¢ per lb, for materials only. At 6% resin content, this would mean that 1.98¢ would be the cost of the resin.

Some savings arise through the smaller amount of sand handled in the foundry when using shell molding as compared with conventional practice. It is the opinion of some methods engineers that these savings could be made large enough to balance out the higher costs of materials and the like in shell molding, so that the process might match costs in the foundry with those of other processes, and the savings in later processing of the pieces would give a decided advantage to the shell molding method. This has not yet been realized in practice.

Patterns must be made to close tolerances to produce close-tolerance shells, and this means high pattern costs. Patterns are usually of gray iron or aluminum, with the former favored because of its greater durability under the constant heating necessary. The cost of a set of patterns necessary to start a job on a production basis may be from about $10,000 to more than $100,000.

The machines used to get high production in making the shells are rather expensive also. A small machine may cost about $5,000, while a large one will require an outlay of about $20,000.

Because the binder is a phenolic resin, and thermosetting, the sand cannot be re-used after simple reconditioning. Burning out the binder in a kiln or oven should make possible its mixing and re-use, but only a large production would warrant the investment in equipment to prepare the sand for recycling. The economy of burning out the binder in the sand may be questioned even if the amount of sand used would be large. With the cost of new sand at about ½¢ per lb, it is doubtful if any considerable saving could be achieved.

With the cost of the process so important in determining the extent of its usefulness, the question naturally arises, what is being done, or can be done, to reduce it? Dominating the materials costs is that of the resin binder. There seems to be little

likelihood of any considerable cost reduction here, because the chemicals are standard, with quantity production long since reached by their use in plastics. The sand is also a standard commodity. The most promising line for economy in the foundry is proportioning the materials. This has been followed to the point that most resin-sand mixtures now contain from 5 to 8% resin in contrast with the earlier mixtures, which contained from 7 to 12%. A limiting condition that seems to be generally recognized is that the finer sands require slightly more resin binder to give satisfactory performance. A guide to resin percentages might be the following suggestions of a foundry engineer using the process for quantity production:

Sands of about 65 AFS number, about 5% resin.

Sands of about 110 AFS number, about 7% resin.

Sands of about 150 AFS number, about 9 to 10% resin.

These figures are approximate only, and may be modified by special conditions. The fact that coarser sands, requiring lower percentages of resin, also give coarser finish to the casting sets a limit to the reduction that can be obtained without sacrifice of quality of finish. Fine sands, of about 110 AFS, are most used at present. It is typical of the process, however, that even with finer sands the molds remain permeable.

The cost of pattern equipment has been approached in the same way. There is little chance for reduction in the cost of making the patterns, and it will be difficult to find a suitable material lower in cost than cast iron. Some hope of reducing the total cost of pattern equipment for a job can come through speeding up the cycle so that fewer patterns will be required. As an example, a large foundry considering a job to be made by shell molding estimated the number of cast iron patterns it would require, and found the cost would be about $100,000, based upon a mold curing cycle of 10 min. Experimental work showed that raising the oven temperature from 550 to 650 F would reduce the cycle to 4½ min, and the pattern equipment was reduced accordingly, bringing its cost to about $40,000. Continuing experiments indicate that the cycle might be shortened to about 2½ min, by raising the oven temperature to 850 F, which would make production possible with a pattern investment of only $25,000.

Applications

In the present stage of development, shell molding is particularly suited for the production of various irons, alloy and stainless steels, aluminum, certain brasses and bronzes, and some high temperature alloys. Some difficulties have been experienced in the production of low carbon steels, and methods are still under development. The sweating of lead in high lead brasses and of tin in high tin bronzes has not been overcome satisfactorily. Methods for preventing the burning of magnesium when cast by this process have been announced recently. Of the applications which have been released by various organizations, some are in commercial production, others are experimental.

The governor body and bushing for all hydromatic drives used by one automotive corporation are now shell castings. Aluminum die castings had been used formerly, but it was found that the iron piston rings used in the mechanism wore the aluminum excessively, and it was decided to change to gray iron castings. Because the castings were very elaborate in design and would have been extremely difficult to machine, a precision casting process was indicated to produce close-tolerance castings with good surface finish. Shell molding was selected. No cost comparison was made with the aluminum die castings which were replaced, but the gray iron parts are giving satisfactory service at reasonable cost.

In another automotive organization, the exhaust valves for an overhead valve engine, camshafts and rocker arms are in production. This organization is also shell-molding a crankshaft from nodular iron on a production basis.

Automotive and tractor parts which have been produced by a manufacturer of agricultural machinery for shell molding include rocker arm brackets, pinion bearing cages, crankshaft pulleys, exhaust pipe flanges and brake drums.

The possibilities of substitution of one material for another with the aid of the new process have not been overlooked. A booster body for artillery projectiles formerly machined from brass bar is now shell molded in a ferrous metal. An automotive door latch striker was produced experimentally as a shell molded iron casting with results which showed that this part could be converted satisfactorily if zinc became scarce.

The ability to reduce machining requirements has been used to advantage in the production of machine components from Meehanite iron. Definite savings have been made by converting to shell molding. Thus, the machining of a crescent guide was reduced 39% and that of a wedge keeper 55%. A motor base plate, which was formerly machined on the top and bottom pads, no longer requires machining, while a nib for the tension roll of a textile machine can be used as cast, after removal of the sprue.

Small castings of types 304 and 316 stainless steel are in production. These include valve bonnets and bodies and pipe fittings such as tees and ells. As-cast weights range from about one to 25 lb. In one foundry, metal yields have been increased by 20 to 35% over the green sand practice used previously. At the same time, shifts, which in sand castings have resulted in rejection rates as high as 40%, are not experienced in shell molds. In this foundry, jet afterburner castings which require close mold matching, rings for a disposal unit, and milk funnels have been produced experimentally from the same metals.

Using a combination of methods, an aluminum diffuser has been made with the face shell-molded and the back (flat) molded in green sand. Sheave-type wheels and impellers are also being produced by the shell molding of aluminum alloys.

By incorporating a mixture of sulfur and potassium fluoborate in the sand-resin mixture, a foundry has been able to overcome the burning of magnesium, which has hampered development of the process for this material, and is producing castings on a commercial basis. One part, which was previously produced as a sand casting with a 50% rejection rate due to misruns, is now produced by shell molding with practically no loss. In addition, finishing operations were greatly reduced. The major difficulty which has been encountered is shaking out the molds, as the sand has a tendency to stick to the casting, particularly in depressed areas.

Among parts which have been produced by this process from copper alloys are bronze valve plugs and sheave-type wheels. Impellers and bypass castings have been produced on an experimental basis from Navy gun metal also.

by **WILLIAM M. RAND, JR.,**
Manager, Container Products Div.,
Dewey and Almy Chemical Co.

New Flowed-In Gaskets

Flowed-in gaskets, which are applied as a liquid and baked in place, offer advantages over pre-cut types in many applications.

. . . Increase Production Speeds

. . . Reduce Faulty Seals

. . . Use Synthetic Rubbers or Resins

● A NEW TYPE GASKET has been developed which provides an improved seal at lower labor and material costs. It can be used in a wide range of manufacturing industries where component parts require gaskets. In many such applications these new gaskets promise to replace standard hand-inserted, pre-cut cork and rubber types.

Called the "flowed-in" gasket, it is applied as a liquid synthetic rubber or resin compound, forced through a nozzle onto a spinning component part and then baked to form a solid rubbery gasket which will not fall off the part. The gasket can be applied either automatically or semi-automatically, depending upon lining equipment used, and in varying types, thicknesses and diameters. The automatic machine can handle parts from ¾ to 12 in. in dia. The semi-automatic can handle parts from ½ to 23 in. in dia.

By this new method, specially formulated rubbers or resins can be made to provide effective seals against moisture, oils, gasoline, many solvents, heat, pressure, vacuum, weather and vibration. Also, compounds can be formulated to produce either cellular or solid gaskets as well as gaskets which swell to insure hermetic sealing of an enclosed seam.

This feature permits engineers to utilize new synthetic rubbers and plastics. Sealing compounds can be formulated or tailored to do the job intended. Active chemicals which might react with contents being sealed can be substituted or eliminated. Special properties of resistance to oil or fumes of virtually any sort can be incorporated. Chemicals such as sulfur that might tarnish silver receptors can be eliminated. The effects of sunlight and weathering can be compensated for.

This new type gasket is now in use at Rochester Manufacturing Co., makers of dial gages. More than a year's production with the new gasket has shown substantial reductions in faulty gasket seals, has increased production speeds, and has lowered labor and material cost.

Old Method Unsatisfactory

A crucial element in Rochester's operations is the need for an hermetic seal of the glass window and metal rim or "bezel" to the metal cases of more than a dozen types of pressure, temperature and liquid level gages. To operate efficiently, these gages require gasket protection against moisture, dust, gasoline, various oils, chemicals and solvents, as well as from vibration and shock.

Under the old sealing method, in which several different kinds and sizes of pre-cut gaskets were used, the incidence of customer rejects for faulty seals was high. This stemmed not only from leaking gaskets, but from deterioration of gaskets from gasoline fumes and other chemicals and from excessive glass breakage due to the lack of proper resiliency of the hard rubber gaskets.

Productionwise, the old method was costly and slow. Different sizes and types of pre-cut gaskets had to be ordered and stocked. In the bezeling operation, all gaskets had first to be hand glued and inserted between the glass and the metal case. Bezeling is the term applied to the

crimping in a press of the metal rims, or bezels, to the metal case. Results were not satisfactory as both gasket and glass too frequently fell out, prior to crimping, causing excessive glass breakage and work duplication.

New Gaskets Solve Problem

To overcome this, the company selected a synthetic rubber compound which, when applied to the bezel and dried in the baking oven, expands into a cellular gasket. The resilient qualities of this gasket, which also holds the glass in place, virtually eliminated glass breakage both in the plant and in the field and produced an hermetic seal.

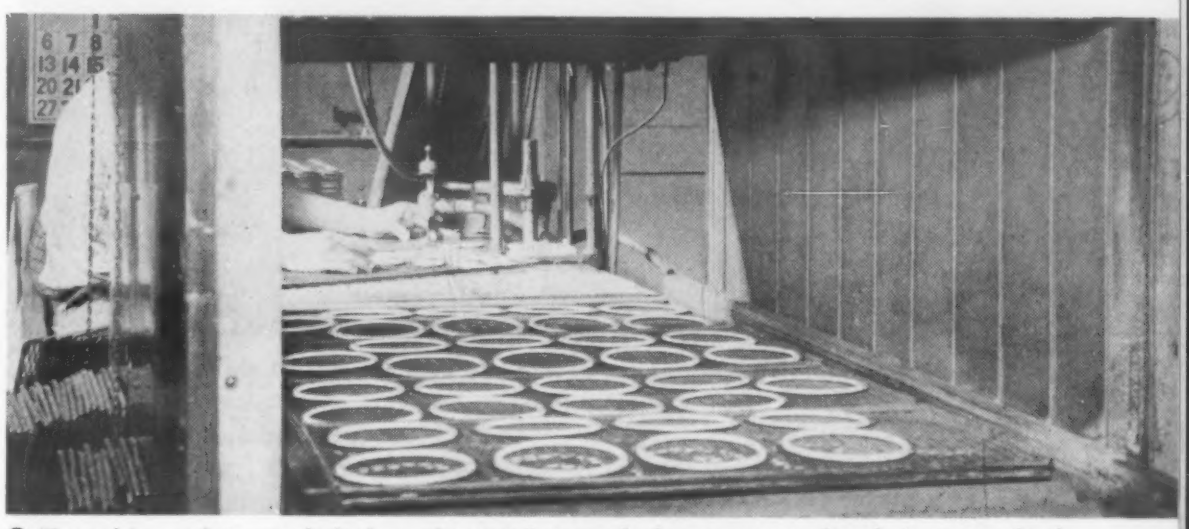
A semi-automatic machine is used for the lining operation. An operator places the bezel to be lined on the chuck, presses a foot pedal which spins and elevates the chuck and activates the nozzle. As the chuck spins, the part receives a measured amount of compound in the channel and is manually removed to a baking tray. When the tray is filled, it is placed in the gas oven where the compound, in drying, puffs out to the proper size.

Production speeds vary, depending upon size of component being lined and operator skill. On the 2-in. bezel, the rate is about 1800 per hr. The semi-automatic machine will handle parts measuring from $\frac{1}{2}$ to 23 in. in dia.

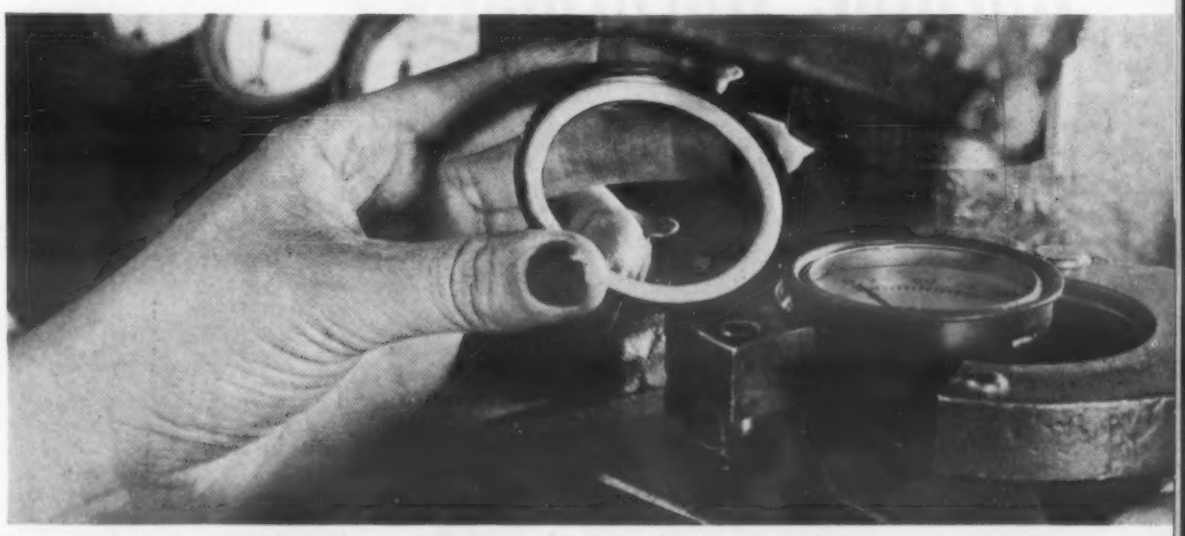
Rochester's experience with the flowed-in method is based on the performance of more than 5 million gages with this type of gasket now in service. They estimate that production cost of the flowed-in gasket is about one-third that of the pre-cut gasket and that it can be applied three times as fast. One flowed-in compound has replaced four different kinds of pre-cut gaskets formerly used, thus eliminating the cost and trouble of stocking and handling extra materials.

The specially formulated gasket compound has also helped Rochester to develop a new technique—effecting an hermetic seal between plastic and metal. A plastic bezel is now successfully being sealed with a flowed-in gasket to a metal liquid level gage designed for use on exterior gasoline and oil storage tanks. The pre-cut gaskets previously tried either did not give a proper seal or deteriorated from the effects of the gasoline fumes.

1 *Cover is placed on a chuck which rises and spins at a touch of the foot pedal. Fixed nozzel squirts measured amount of liquid on the spinning cover.*



2 *Flowed-in gaskets are baked on the metal-rimmed glass covers or bezels in a gas-fired oven.*



3 *Gasketed bezel is crimped on instrument case after baking. The cellular gasket provides a hermetic seal and acts as a shock absorber.*

4 *Final test is given under 5 psi water. Gaskets hold glass in place, eliminating glass breakage.*

Close-up shows how carbide particles are poured into pool of molten base metal to produce a wear resistant coating.

Carbide Hardfacing by New Inert-Gas-Arc Method

by J. J. Barry, Air Reduction Sales Co.

Tough, wear resistant coatings deposited on steel. Advantages include: (1) automatic, fast deposition; (2) shallow heat-affected zone; (3) good bonding; and (4) little dilution of carbide particles.

● A NEW DEVELOPMENT in automatic hardfacing is the process recently developed by Air Reduction which employs the inert-gas-shielded arc method and deposits tungsten carbide particles from a vibratory hopper. It promises to be particularly successful on heavy sections of both new and old equipment and mechanical parts. It is also effective for facing thin edges.

Growing out of a need for improved methods in depositing tungsten carbide hardfacing material on tool joints for well drilling rigs, the flexibility of the method has been proved by numerous tests, which show that its use for the deposition of tungsten carbide hardfacing materials is limited only by the ability to position the work and the arc in the proper relationship to each other.

In operation, the inert-gas-shielded arc melts the base metal, producing an elongated pool, and the tungsten carbide particles are poured into this pool behind the arc. The manner of deposition of loose, granular, pure tungsten carbide particles minimizes reduction of particle size by solution of the tungsten carbide into the base metal. It also minimizes the heat-affected area adjacent to the deposit.

Metallographic examination of the deposits shows the tendency of the tungsten carbide particles to remain intact rather than fragmentize, and there is little evidence of melting of the particles as would be indicated by rounded corners. Good alloying and satisfactory bonding between the carbide particles and the matrix is also revealed.

This process offers the production advantages of speed without sacrificing the quality obtainable with slower methods of deposition. More specifically, tests demonstrate that it produces the quality of deposits obtainable with the manual oxyacetylene method of deposition while it equals in speed, with better quality, the production rates of other automatic arc methods of deposition.

A good case history of this method is its application to tool joints on oil well drill pipe. These drill pipes, made up in sections approximately 40 ft in length and coupled by a tapered thread connection, extend to the depth of the hole which, in some cases, runs up to three miles. The couplings or tool joints are subjected to severe earth and rock abrasion against the sides of the holes.

When the use of tungsten carbide on tool joints for extreme abrasive service became widespread, the oxyacetylene method was used first to apply it. However, this method was too slow for the large number of joints being reclaimed. The next step was arc welding with electrodes of the "stick" variety. Automatic submerged arc welding was next in line and is still widely practiced. However, with these arc methods, some of the tungsten carbide dissolves into the base metal, making it crack sensitive for subsequent heat treating operations. The new process employing inert-gas-shielded tungsten arc welding process is proving its efficiency in minimizing carbide solution into the base metal.

In this particular application, the inert-gas-shielded tungsten arc is used to melt the base metal, producing an elongated molten pool behind the arc. Tungsten carbide particles are poured into the puddle and the molten metal freezes around the car-

bide particles, locking them in.

The rate of feed of the carbide particles from a vibrating cone-shaped hopper is electrically controlled. The size of the particles is 30-40 mesh. These have been found to give the best distribution through the weld bead. Metallographic specimens show an optimum alloying between the carbide and the matrix, as illustrated by a narrow white border on the carbide particles.

Abrasion tests on hardfacing deposits made by this method indicate that resistance is comparable to that obtained by the oxyacetylene method and better than any of the results for arc welded deposits. There is no cracking and only minor porosity. The hardness of the matrix ranges between 48-51 Rockwell C, which is midway between optimum hardness for toughness and abrasion resistance.

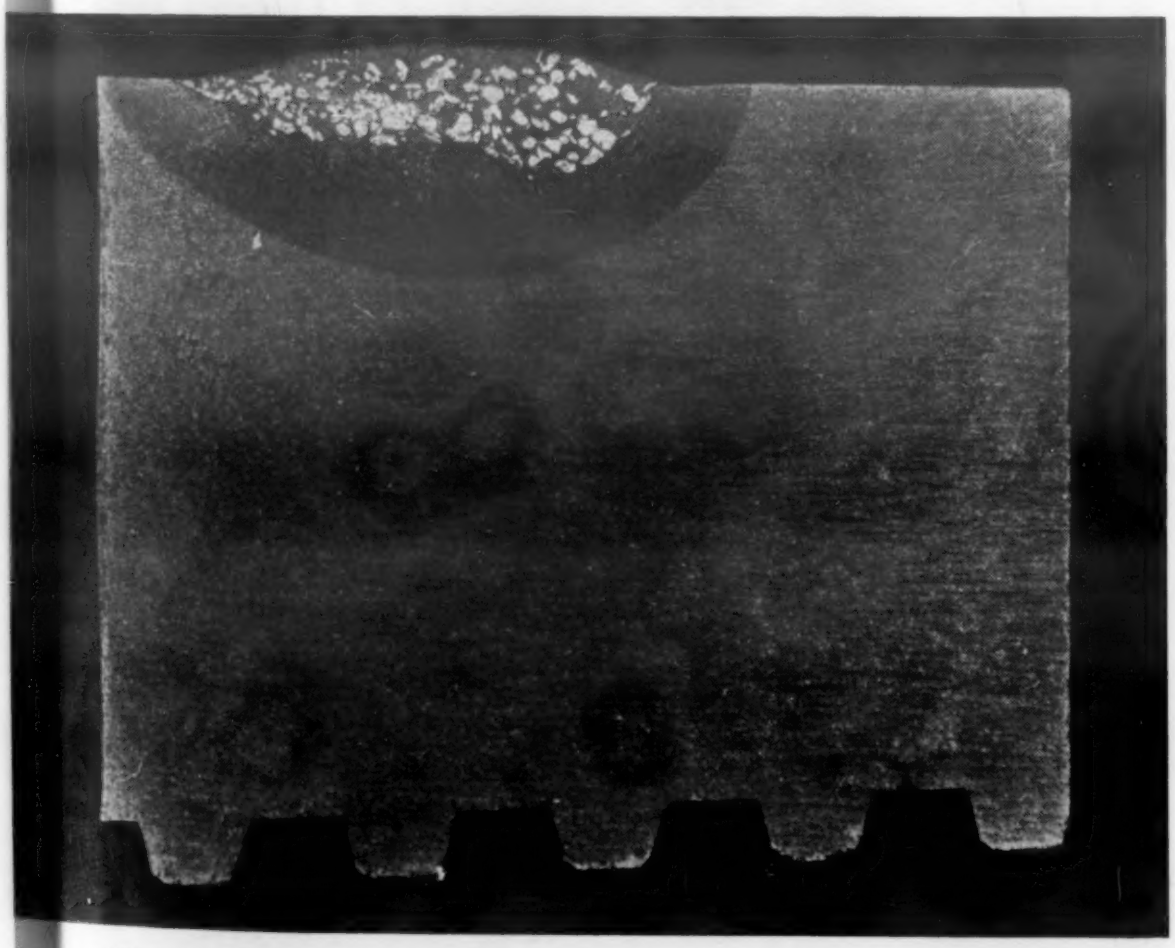
Comparison of this new method of hardfacing tool joints with tungsten carbide with that of manual welding with electrodes shows that the new method provides efficient carbide distribution, less enrichment of the matrix with carbon and tungsten, and less cracking. The increase in abrasion resistance over conventional arc deposits is much greater.

Another advantage over both gas and conventional arc applications is that it uses loose granular carbide, while a fabricated rod is required by the older methods. It is automatic in operation, of course, while oxy-acetylene deposits must be made manually. All of these advantages depend, naturally, on appropriate adjustment of controlling factors in the procedure.

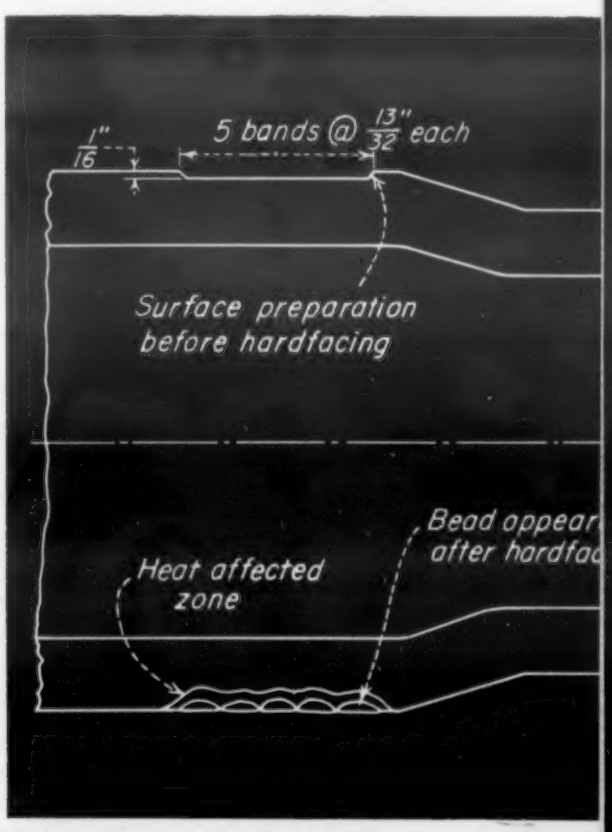
In general, if present and potential users of hardfacing are to take advantage of the maximum effectiveness and economies of the basic process, it is important to realize that the proper selection of the method of deposition can be as important as the proper selection of the material for the deposit. Inefficiencies are often concealed by results which are satisfactory, but do not represent the best operating economies, nor do they impart to the part the maximum service life obtainable.

This new automatic method, by offering production rates as fast as other automatic arc methods while producing a superior deposit for abrasion resistance, makes possible economies derived not only from the operation itself on volume, repetitive works, but from the hardfaced part itself through extra service life.

Basic inert-gas-shielded arc welding unit adapted for hardfacing. Carbide particles are fed through tube from vibratory hopper at top.



Macrograph of cross-section of the hardfacing. White areas are the tungsten carbide particles. Dark band shows narrow heat-affected zone.



Sketch illustrating method adopted for hardfacing new tool joints on oil well drill pipe.

—A PICTORIAL STORY

Adhesive Joining of Wood-to-Steel Increases TV Cabinet Production

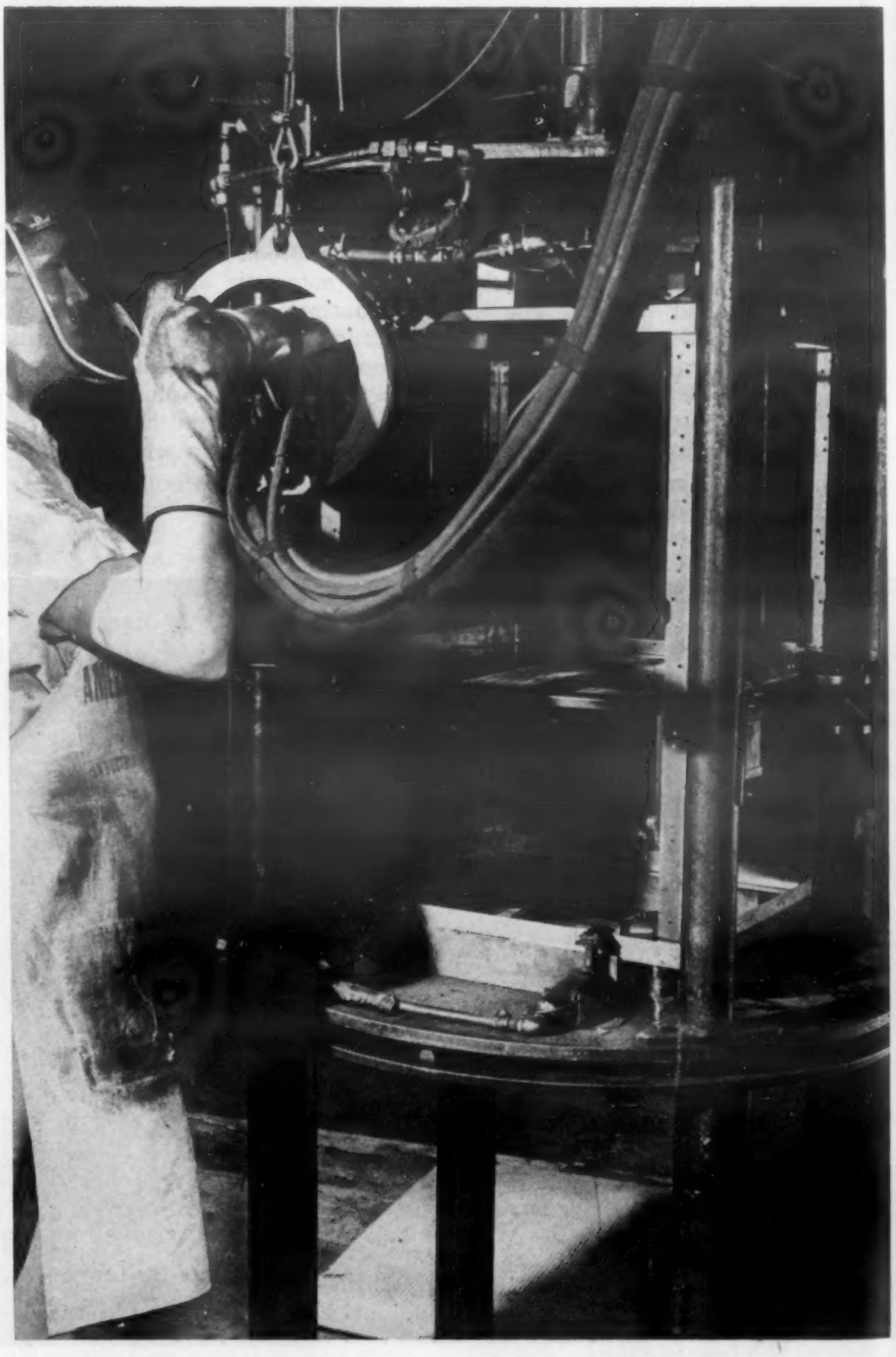
Rubber resin composition provides high bond strength

● A NEW METHOD of joining wood to steel with adhesives has made it possible for the Carrollton plant of Avco Manufacturing Co. to increase their television cabinet production up to 150%. The new system hinges on applying pre-cut veneered plywood panels to a welded steel framework with a rubber-resin adhesive. The method (shown in part in Avco patent 2,562,257) has resulted in a significant decrease in cabinet costs, freed skilled woodworking mechanics for more critical operations, and solved one of the remaining bottlenecks to full capacity TV production.

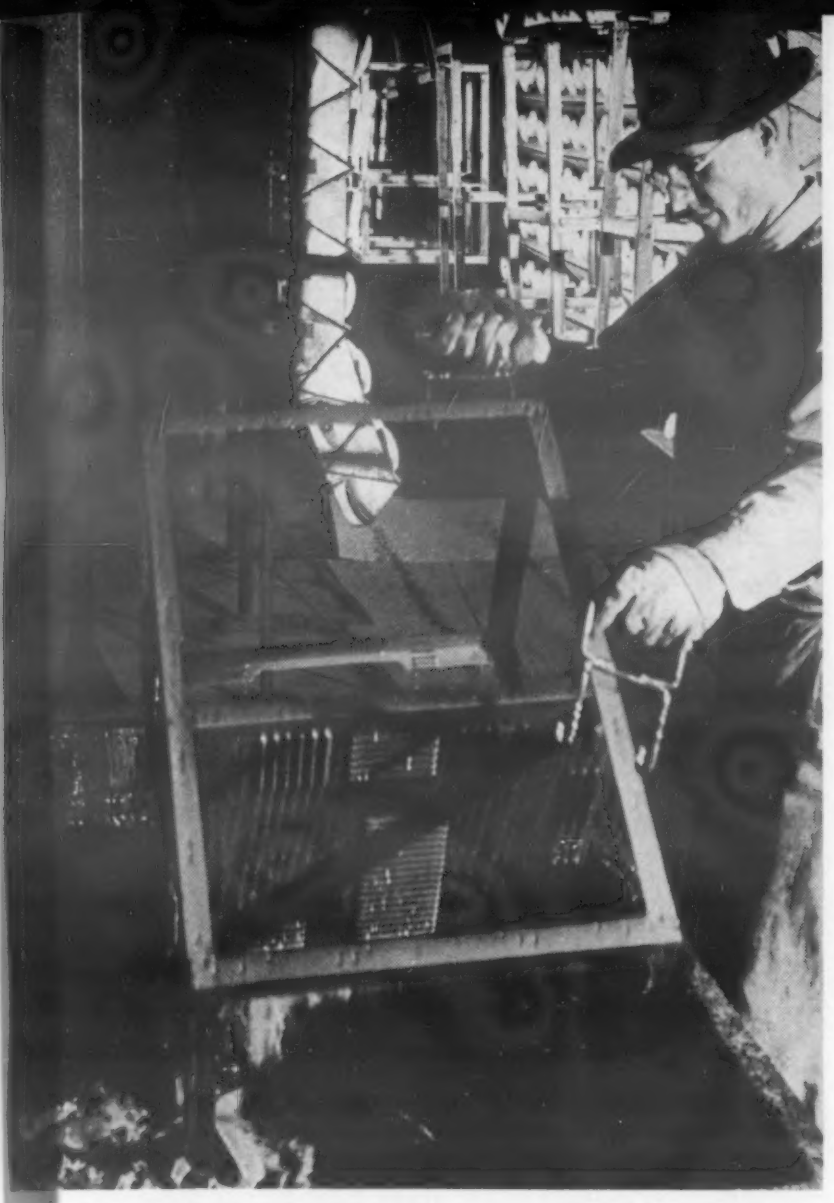
When Avco engineers first conceived this radically new approach to cabinet fabrication, they sought an adhesive that would firmly bond together wood and steel, and provide nearly maximum bond strength as soon as the two pieces were pressed together. After investigating the problem, the Adhesives and Coatings Div. of Minnesota Mining and Manufacturing Co. recommended two adhesives for the job. The first adhesive acted as a "primer" on the steel framework. The second adhesive was applied both to the steel frame and the plywood panels, and provided a satisfactory bond within seconds after the pieces were mated and pressure bonded in special presses of Avco design.

After thorough testing by both Avco and 3M, a production line was set up at Avco's plant at Carrollton, Ky. At first the adhesive bonded cabinets represented a small share of the total TV cabinet output, but rapid field acceptance of these models, and their lower cabinet price, has resulted in a decision to convert the majority of their cabinet production to this new method.

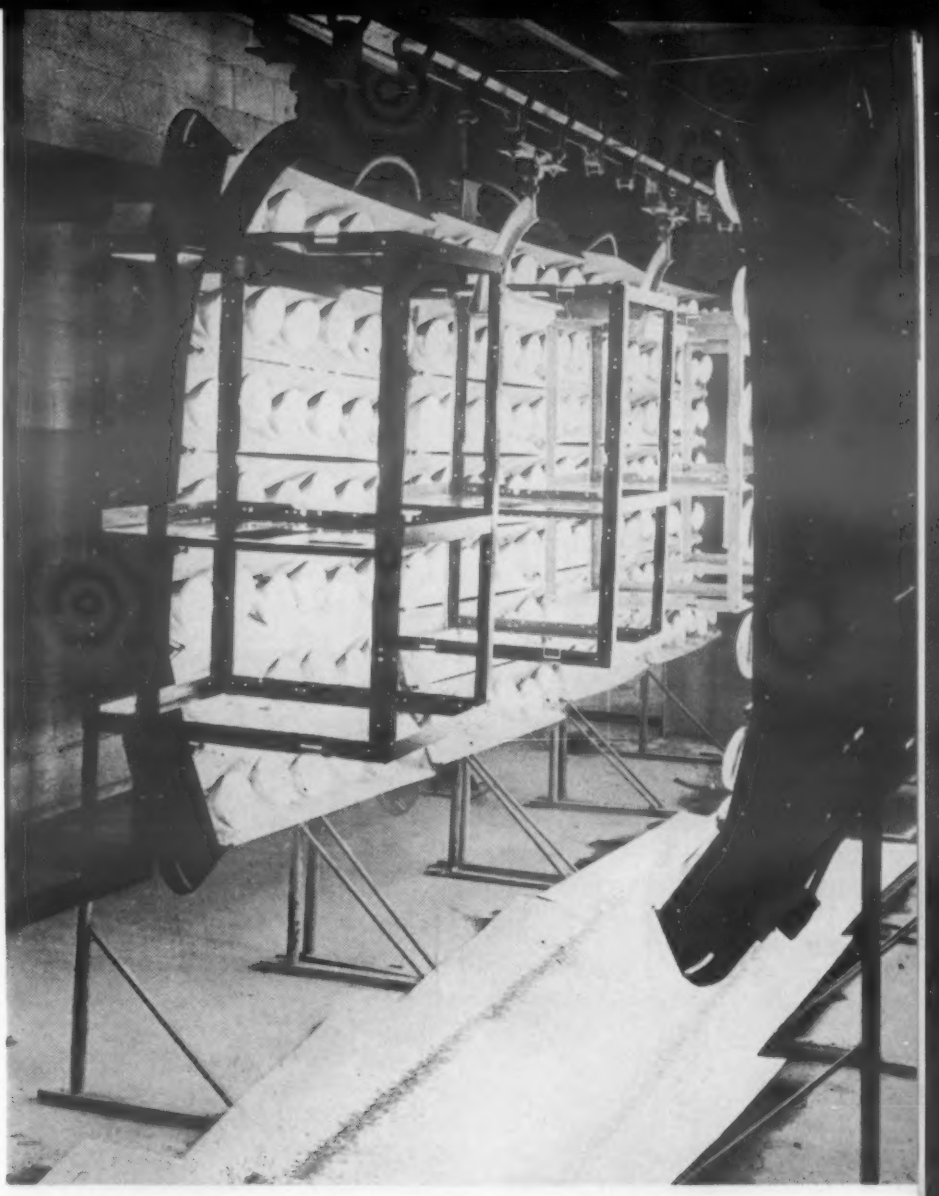
A brief description of the steps in producing the cabinets is given in the accompanying captions.



1 *STEEL FRAMEWORK of TV cabinet is fabricated by spot welding the base plate, upright sections and chassis mount into one unit.*

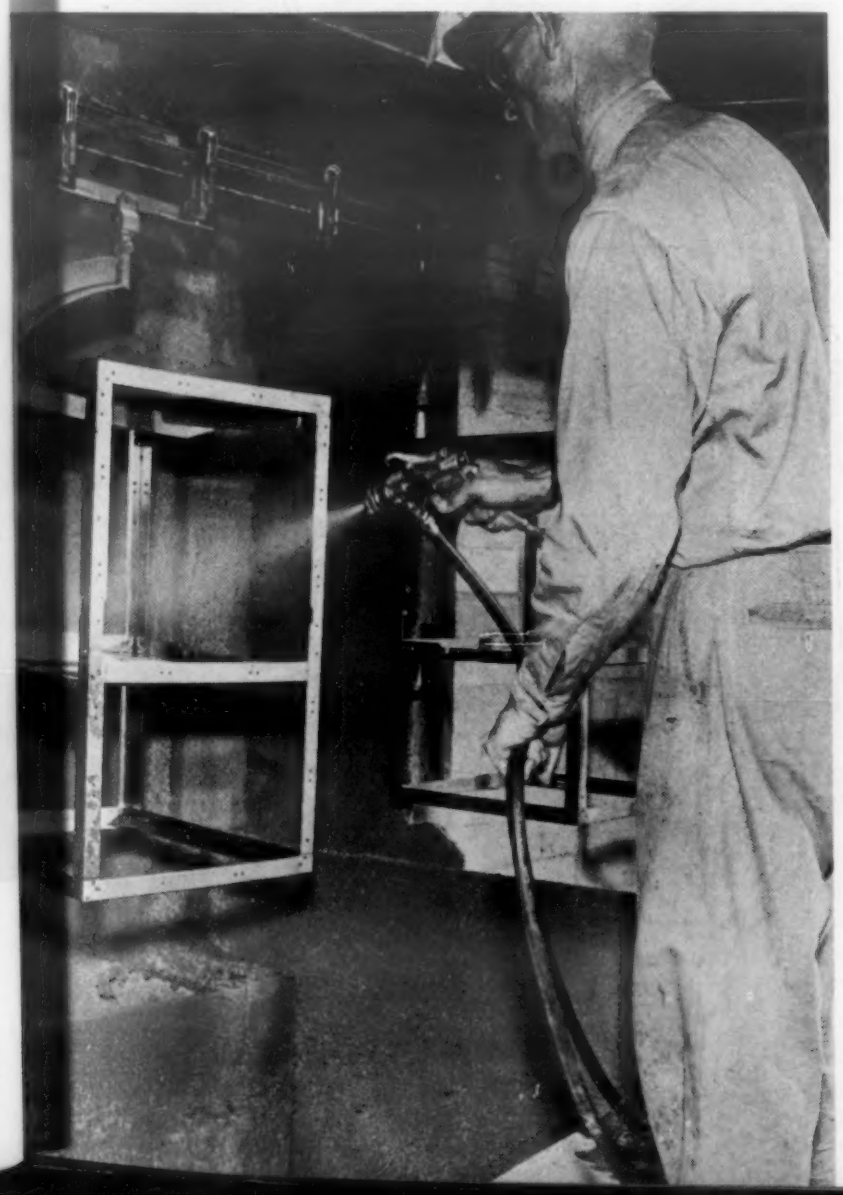


2 *FABRICATED FRAMES, after passing through a three-stage degreaser and drying oven, are hand-dipped in a tank receiving a thorough coating of primer adhesive (EC-880).*



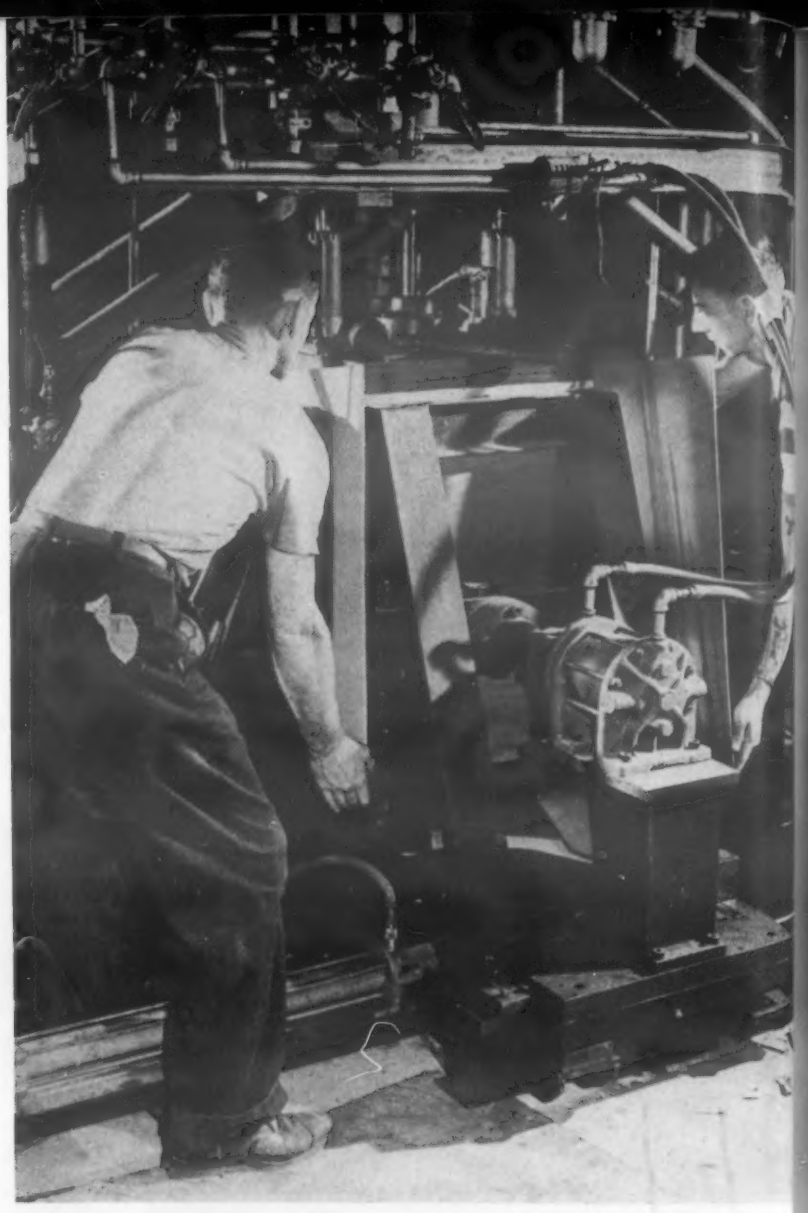
3 *COATED FRAMES are passed through an infra-red drying oven for about 3 min at a temperature of 150 F.*

4 *OVEN-DRIED PRIMER is overcoated with a second adhesive (EC1079). It is applied by hand spraying. Coating is then air-dried for a few minutes before final drying in an infra-red oven for 3 min at 200 F.*



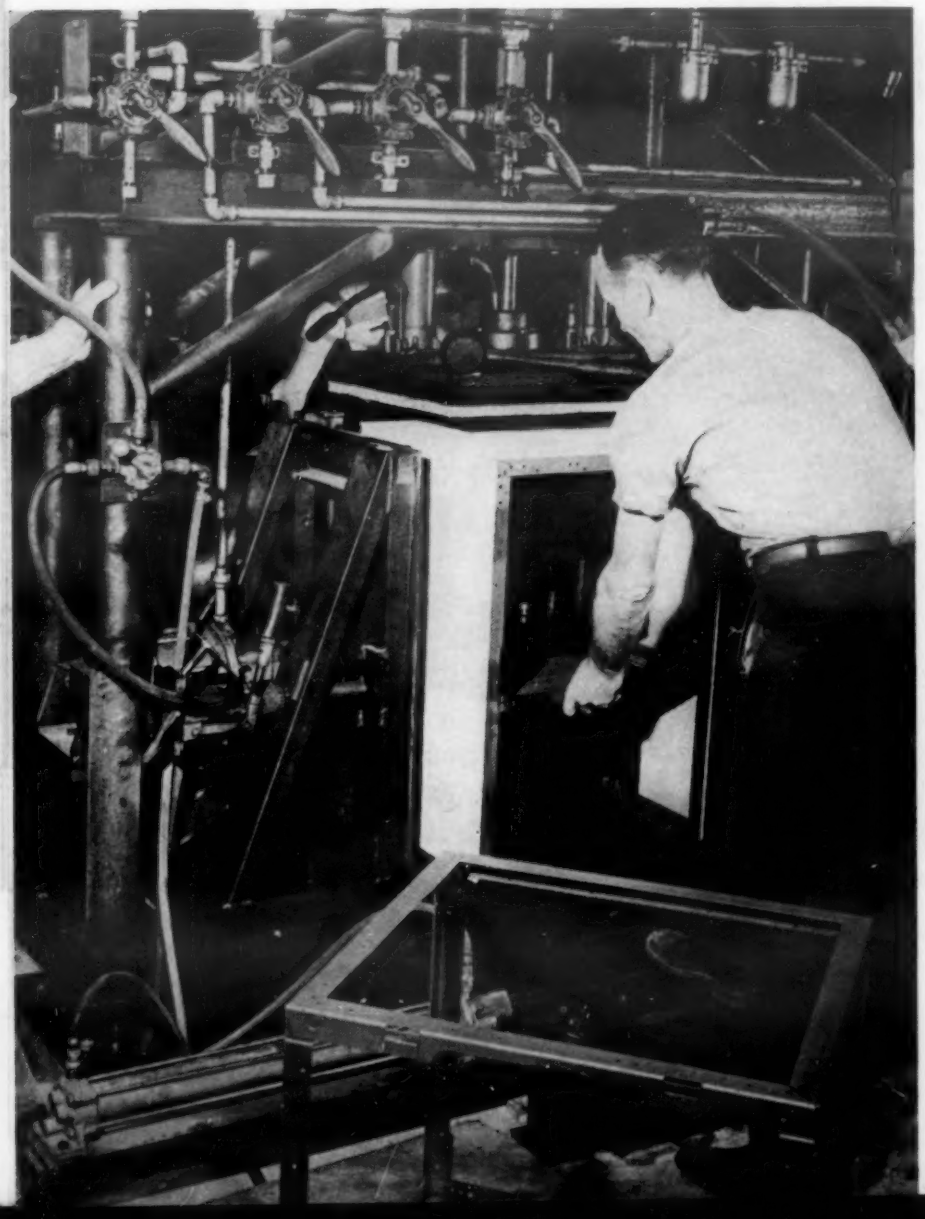
5 *VENEERED PLYWOOD PANELS are prepared by spraying them with adhesive (EC-1079) while steel frames are being fabricated.*

6 *ADHESIVE COATED PANELS pass under a bank of infra-red lights. Time is 3 min and temperature is about 150 F.*

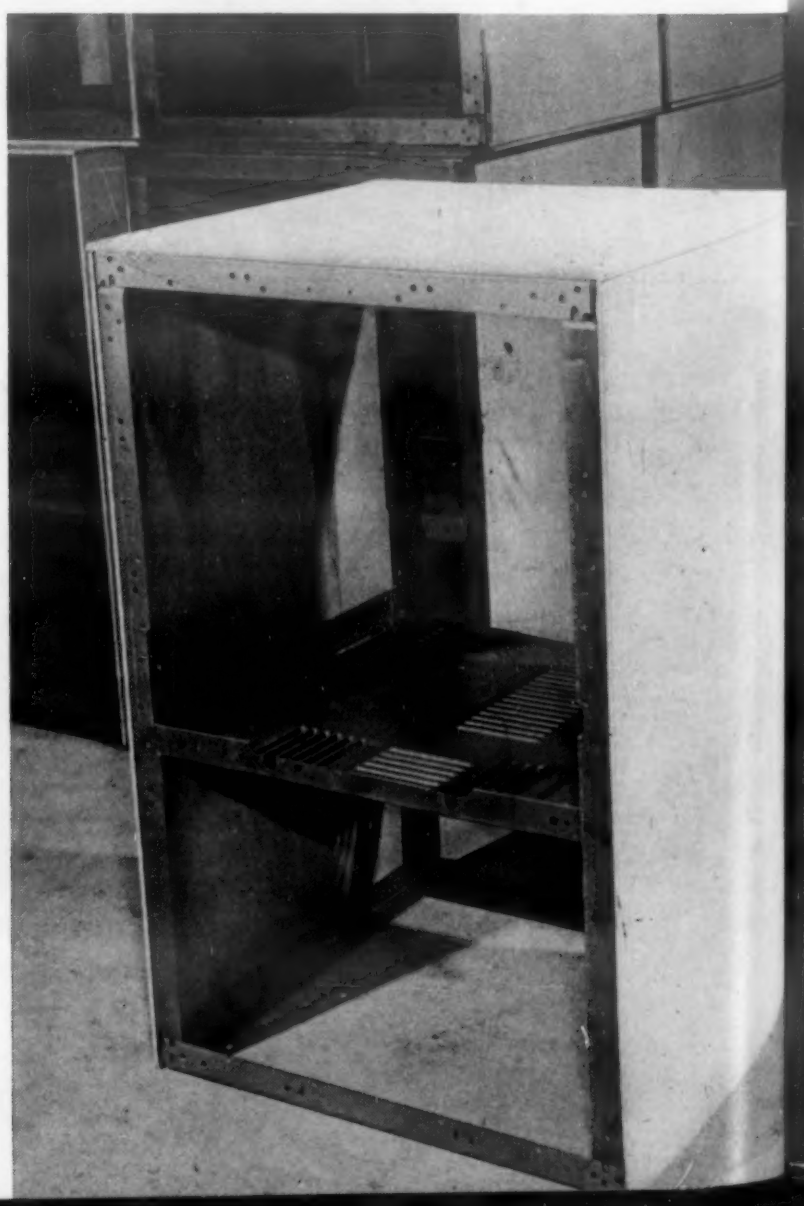


7 *FRAME AND PLYWOOD PANELS are joined to make cabinet assembly by pressing together in case-clamp press for about 3 min.*

8 *REMOVING CABINET FROM PRESS after joining operation is complete.*



9 *COMPLETED CABINET ready for further processing and final finishing.*



HIGH-SPEED STEEL CUTTING TOOLS, after steam treatment, average 20 to 25% longer life.

BRASS FITTINGS being loaded for stress-relieving in a steam atmosphere. After this treatment, parts to be plated need only a bright dip.

CAST IRON AUTOMOTIVE PARTS, which formerly required a chemical surface treatment for proper lubricating properties, need no supplementary treatment after being steam treated.

BERYLLIUM-COPPER PARTS, age-hardened before plating, formerly required three cleaning operations, and rejections averaged 25%. Now they are steam hardened, bright dipped and plated with no rejections.

Many Common Metals Successfully Treated in Steam Atmospheres

by **F. L. SPANGLER**, Leeds & Northrup Co.

Method makes possible scale free tempering, annealing and stress relieving. . . . In many applications resulting oxide film provides an attractive, durable finish.

● TEMPERING, ANNEALING AND stress-relieving by the steam atmosphere treatment, commonly referred to as the Steam Homo Method, is enabling many plants to turn out work which has superior resistance to wear, longer life, better machinability, and greater resistance to corrosion. At the same time, many time-consuming finishing operations are reduced or completely eliminated. The safety and small space requirements of the equipment make it entirely practical for installation directly in production lines.

This heat treating method is safe and inexpensive. It provides scale-free heat treating of both ferrous and nonferrous parts at temperatures to 1150 F. On ferrous metals, the steam atmosphere produces a thin controlled oxide coating which gives the parts a number of desirable qualities. On nonferrous metals the steam atmosphere retards oxidation, thus eliminating or reducing subsequent cleaning operations.

The operation is simple. The furnace is brought to 700 F with air atmosphere and held at this temperature for half an hour while steam is injected to purge the air from the work chamber. The load is then heated to soaking temperature and held for the specified time, with steam flowing through the furnace.

***ALUMINUM ALLOY CLUTCH ARMS** given solution treatment in steam saves up to 40% of the cost of subsequent buffing operations.*

***SURFACE APPEARANCE** of brass parts before stress-relieving (left), after stress-relieving in air (center), and after stress-relieving in steam.*

At the end of the soaking period the work is either air-cooled or quenched in soluble oil. When handling nonferrous material requiring lower temperatures, the furnace can be purged as low as 400 F and parts are often quenched in water.

After heat treatment, iron and steel parts are covered with a thin blue-black film of oxide. This film, which is uniform, tough and durable, makes an excellent final low cost finish for many parts. It is sufficiently porous to retain lubricants during machining and grinding operations. On other applications the oil retention of the film yields improved corrosion resistance as well. On the other hand, if the part requires plating for finishing, the uniformly thin oxide coating can be removed by a brief pickling operation.

Applications

Steel parts such as hardened bolts and studs, precision castings, cold headed bolts or deep drawn parts, tempered or stress-relieved in a steam atmosphere, come out clean and free from scale. The tightly adherent oxide coating formed by the steam atmosphere makes an attractive final finish. Also, its porosity retains lubricants well so that oil dipped parts have better corrosion resistance and machinability than untreated parts.

Drills, reamers, hobs, milling cutters and other high-speed steel cutting tools hold their edges 20 to 25% longer when steam treated following tempering and final grinding. This ratio goes up, often as high as 6 to 1, when cutting such materials as high chromium, high carbon steels, with the result that fewer tools are needed and less time is spent changing and sharpening them.

The tough porous oxide film mentioned previously is responsible for this longer life. Though micro thin, the film insulates the tool from the material being machined and prevents chips from "welding" to the cutting edge. The film's ability to store oil contributes as well, giving better point-of-contact lubrication during machining.

Cast iron parts such as cams and bearings, valve tappets, pistons and piston rings derive better wear and wearing-in properties from steam treatment. The oxide film retains lubricants and helps cushion parts while they lap into perfect fit during the break-in period.

The hardness and compressive strength of sintered powdered iron compacts is often doubled when they are oxide-impregnated by steam treating. Resistance to wear improves too, since the hard oxide partially fills the pores of compacts and offers its own resistance as parts wear down. Finally, the porous film's ability to store lubricants gives oil-dipped parts better wearing-in properties and corrosion resistance.

Brass and bronze parts such as valve fittings, fasteners, cosmetic containers and cartridge cases can be annealed and stress-relieved in a steam atmosphere. Many parts come out clean enough for use. Others, which require plating, need only a quick bright dip to remove the slight discoloration formed during steam treatment.

Steam atmosphere heat treatment of brasses and bronzes, in many cases, permits elimination of pickling and other surface cleaning operations and results in more work being processed in less time at lower unit cost.

Beryllium-copper parts such as electrical switch components, which must be plated after age-hardening, can be heat treated in a steam atmosphere without scaling. Pickling operations are eliminated, except for a bright dip prior to plating.

Aluminum parts, which acquire a heavy matte coating on heat treating in an air atmosphere, receive only a light gray coating in steam. Therefore, such aluminum alloy parts as stamped electrical instrument clutch arms, which must be solution-treated as one of the final processing steps, need less buffing after steam atmosphere heat treating.

IMPACT RESISTANCE of chopped glass-filled molding resins is demonstrated here. Dish is made of the alkyd type material. (Plaskon Div.)

GOOD ELECTRICAL PROPERTIES AND DIMENSIONAL STABILITY are features of glass-fiber reinforced materials. This transmitter-commutator is made of a new alkyd type glass fiber-filled molding compound. (Plaskon Div.).

What Glass Fiber-Filled Molding Resins Have to Offer

by **KENNETH ROSE**, Mid-Western Editor, Materials & Methods

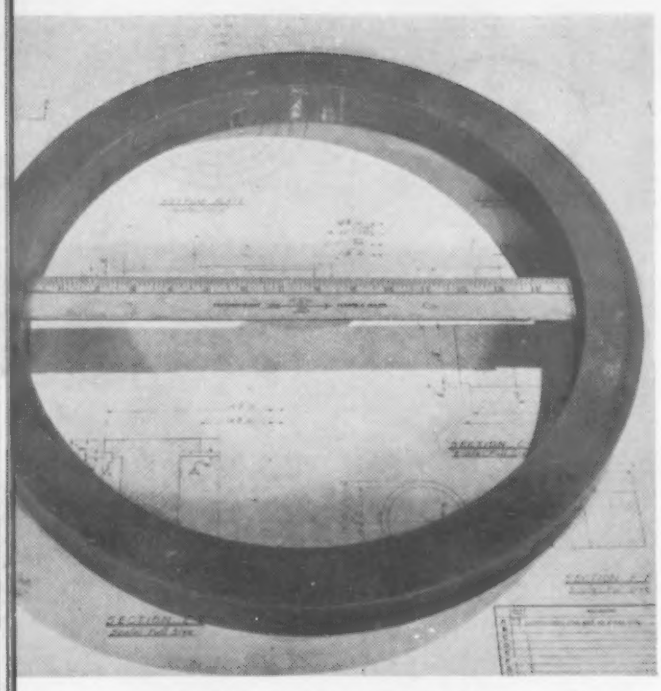
Recently developed compounds now make practical use of glass reinforced plastics for small pieces and for parts of varying thicknesses.

● GLASS FIBER reinforced plastics products made using fiber glass mats, preforms or cloth have become widespread in recent years largely because the strengths of these materials are superior to other plastics and, on a weight basis, to steel and aluminum. However, production techniques make such products most practical in large pieces with constant wall thicknesses. To make small pieces economical and with varying thicknesses, several new molding compounds using chopped glass fibers and inert fillers have been developed.

These glass fiber reinforced molding materials have been molded by compression and transfer processes to produce materials of high impact strength. Some of them are already commercial, while others are still in the experimental stage. Many molders prepare their own molding material by mixing resin and fibers and placing in the mold cavity. In other cases the resin and fiber mixture can be obtained as a standard material from the resin manufacturer.

Molded glass-filled plastics, in general, must fit into a rather narrow niche in the materials selection picture. The glass fiber reinforced molded plastics, both laminates and chopped-fiber-filled molding compounds, are expensive, and cannot compete costwise with aluminum, magnesium, ferrous metals or wood where these materials can give reasonably satisfactory service. One authority in the glass-reinforced plastics industry states that, to compete economically with metals and other nonmetallics, laminated or preformed parts should have sections not exceeding ¼ in. in thickness, to permit rapid cure and to hold press time to a minimum. The parts will cost about 80¢ to $1.25 per lb, if held to economical sections.

The molding resins containing chopped glass fiber as a filler, rather



***EXCELLENT HEAT RESISTANCE** is the outsanding property of the silicone type glass-filled molding material used in this induction heating coil retainer ring. Rings of this type, subjected to alternate heating and cooling, are still in service after two years. (Dow Corning Corp.)*

***GOOD MOLDING** characteristics, among other things, were required of the glass-fiber-filled alkyd molding compound to meet the design requirements of this arc welding electrode holder. (Plaskon Div.)*

than as a laminating material or as a preform, are best suited to those parts in which both resin and reinforcement must flow during molding. Pieces small in size, having substantial changes in section thickness, and having ribs, blind pockets, and the like, are the type of part for which glass-filled resin molding materials should be considered. The standard glass fiber-filled resins now available as standard premixed molding materials might be chosen where their own type of resin was the one required, or the plant-mixed combination of resin and chopped glass fiber might be used.

The glass-filled plastics are primarily shock-resistant materials. Properties depend to a considerable degree upon the molding operation, and especially upon the time and speed of cure and the pressure applied during cure. Properties can be given in a general way only, therefore, and must be read realizing the wide variations possible. The glass-filled types possess good heat resistance, good electrical properties, and good dimensional stability also.

Alkyd Type

One of the first of the standard molding materials in this group was the glass-filled alkyd molding compound of Plaskon Div., Libbey-Owens-Ford Glass Co. Because the compound is a complete molding material as offered to industry, without any need for mixing catalysts or other ingredients, it offers the advantages of (1) a reliable molding performance, due to more accurate control of formulation; (2) minimum preparation at the molder's plant; and (3) more uniform physical and electrical properties. The prepared material is moldable on standard presses, and keeps well in shipping and storage.

The alkyd material is a thermoset, and is usually compression molded. As supplied to the molder the material has a high bulk factor, and it is sometimes necessary to compress it to get the proper amount of material into the mold. Simple compression in a hand press will reduce its bulk by about one-half. Mold design should be such that, when overall strength is required, the resin will flow as little as possible during molding, and so will have a minimum tendency to orient the fibers. Orientation of the fibers gives directional value to the strength properties, and so may be useful when the direction of maximum stress in service is known.

As with the unreinforced alkyd material, the press should be fairly fast-acting. Molding temperatures may range from 275 to 330 F, with the preferred range from 290 to 310 F. Mold pressures are of the order of 1200 to 2000 psi. Molds should be of hardened die steel, and should be chromium plated to withstand abrasive action of the material during molding.

Some general properties of the alkyd molded material are given in the accompanying table. The glass-reinforced compound, like the same material without reinforcing, is self-extinguishing, has good resistance to weak acids, poor resistance to alkalies, good resistance to hydrocarbon solvents, and fair resistance to ketones and chlorinated solvents. It may be stored at temperatures up to 70 F for periods as long as six months, and at higher temperatures for shorter periods. At 90 F the molding material will be storable for about one month. Moisture must be avoided at all times.

The glass-reinforced alkyd molding material is being used for the insulating material on the clamping jaws of arc welding electrode holders, for small electric motor parts, for electric coil bobbins, for stand-off insulators, and in circuit breakers.

Silicone and Fluorocarbon Types

Another premixed material, of rather recent announcement, is a specialty molding compound containing chopped glass fibers, and a silicone bonding resin, with inert inorganic fillers. It is light brown in color. This composition is suitable for compression molding or transfer molding, and can be used with or without preforming. It is produced by Dow Corning Corp. under the trade designation Molding Compound XM-3. It has as its special features excellent electrical properties and heat resistance, especially at high humidity. It possesses good impact strength also. As with the silicones in general, its heat resistance is one of its important features, and molded parts are suitable for use at temperatures to about 480 F continuously, or to about 575 F for intermittent service. General properties of this material are given in the accompanying table.

The molding should start with preforming, if needed, at room temperature, and with a cure in the mold at about 350 F for 15 min, under a pressure of about 1000 psi. These conditions may be varied by changing the resin or other material in the formulation.

Some of the present or projected uses are for molded switch parts in electrical items, brush ring holders, and coil forms, and for parts for induction heating units. The compound offers premium properties at a premium price.

Another plastics material used for heat resistance, and for chemical resistance as well, is the polyetrafluoroethylene offered by du Pont as Teflon. Because the molded material shows some tendency to cold flow, it is sometimes compression molded with a chopped glass fiber filler. High in cost, the Teflon parts are usable to about 500 F and to about —1000 F, with good strength and a degree of flexibility over the service range. It is difficult to mold, because even at the high molding temperature of about 625 F or higher the material is extremely viscous. The chlorotrifluoroethylene polymers offered by Kellogg Co. as Kel-F and by Bakelite as Fluorothene are more easily molded, but have a service maximum of about 390 F and are even higher in cost than Teflon.

Properties of Glass-Filled Alkyd Molding Compound

Impact Strength, Izod	10 to 20 ft lb per in. of notch
Tensile Strength	6000 to 10,000 psi
Flexural Strength	14,000 to 17,000 psi
Compressive Strength	20,000 to 25,000 psi
Specific Gravity	2.0
Water Absorption, 24 Hr at 25 C	0.10 to 0.20%
Heat Resistance, Short Time	to 400 F
Long Time	to 300 F
Dielectric Constant, 60 Cycles	5.2 to 6.0
1 Megacycle	4.0 to 4.5
Arc Resistance (ASTM D-495)	180 sec +

Polyester Types

For pieces to be molded from polyester resins, it may be desirable to mix resin, glass fiber, filler, catalyst and pigment together and to use this mixture in the mold. The procedure at Molded Resin Fiber Co. is an example. With liquid resin the mixing may be done in sigma blade dough mixer. The fiber content depends upon the use to which the piece is to be put, and upon the type of mold. The glass fibers are prepared by reducing mat trimmings in a hammer mill. Fiber length may be from ¼ in. to 2 in., with the shorter lengths giving better moldability in the mixture and greater density in the finished piece. While the process produces random lengths, the amount of reduction approximately determines fiber length. The fiber content is about 25 to 30%.

The viscosity of the resin-fiber mixture as placed in the mold is very high—a thick stringy putty. The molds are heated by hot water at 35 psi pressure, bringing the water temperature to about 240 F. The molds are at about 225 to 230 F. As the mold closes rapidly, the resin softens, and the last inch of travel is slowed to permit the free-flowing resin to fill the mold cavity completely. The cure cycle for the polyester resins is about 2 to 2¾ min, with the mold pressure at about 200 to 250 psi.

Molds are made of high-carbon steel. The finished surfaces are polished to a 300-grit finish. Pinch-off edges on the molds are flame hardened. There is no evidence of the glass fibers wearing the dies, even though the dies are not usually chromium plated.

An advantage of the molded plastics pieces is the much lower tooling cost than for production of similar pieces in metals. A part that required a $25,000 die when die-cast in aluminum was produced as a glass-reinforced polyester molding with a die cost of $3,000. This would give the plastics piece a considerable advantage for short-run parts. The molded polyesters are used for machine housings, switch covers, small drip pans, and electrical parts.

Phenolic and Polystyrene Types

A new complete glass fiber-filled molding resin has recently been announced by Durez Plastics and Chemicals Co., in which the glass fibers are saturated with a phenolic resin cured to the B stage. Fibers are of about 1-in. length for most applications, but the length could be varied for special purposes. The saturated fibers resemble chopped match sticks, and serve as practical preforms in themselves. Impact resistance is excellent—of the order of 12 to 20 ft lb per in. of notch. Water resistance, chemical resistance, and heat resistance are good, and electrical properties are good. Electrical properties are not equal to those of the best mineral-filled phenolics, but impact strength is very much better. Water resistance is better than that of the glass-filled polyesters. This phenolic is too new to have been adopted for many purposes, but its field of application lies with the impact-resistant materials.

Polystyrene molding materials with glass fiber filler have been tried in injection molding. Results have not been uniformly satisfactory, and the method is not yet commercial. One reason is that polystyrene formulations of good impact strength without filler can be had from many suppliers of the material, and another is that the glass-filled material is difficult to mold without segregation. Molding of polystyrenes containing chopped glass fibers is still under study, however.

Properties of Glass-Filled Silicone Molding Compound

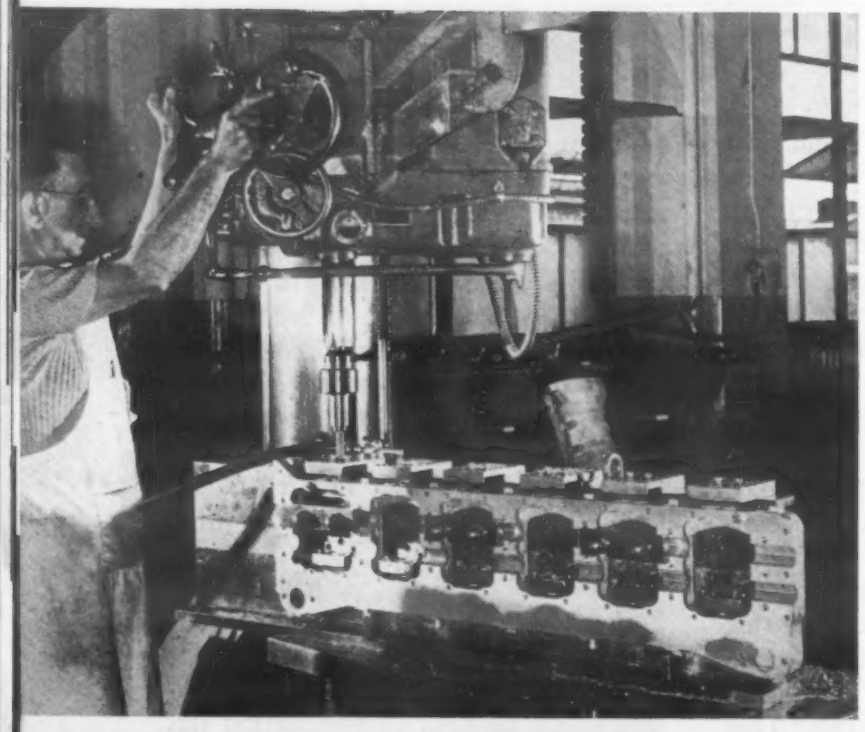
Impact Strength, Izod:	
Room Temp.	7 ft-lb per in. of notch
300 F	5 ft-lb per in. of notch
Tensile Strength	4000 to 6000 psi
Flexural Strength:	8000 to 10,000 psi
Room Temp.	5000 to 6000 psi
300 F	
Compressive Strength	10,000 psi
Specific Gravity	1.6 to 1.7
Water Absorption, 24 Hr	0.2%
Heat Resistance, Short Time	to 575 F
Long Time	to 480 F
Dielectric Constant, 100 Cycles	3.91
1 Megacycle	3.79
Arc Resistance	250 to 300 sec

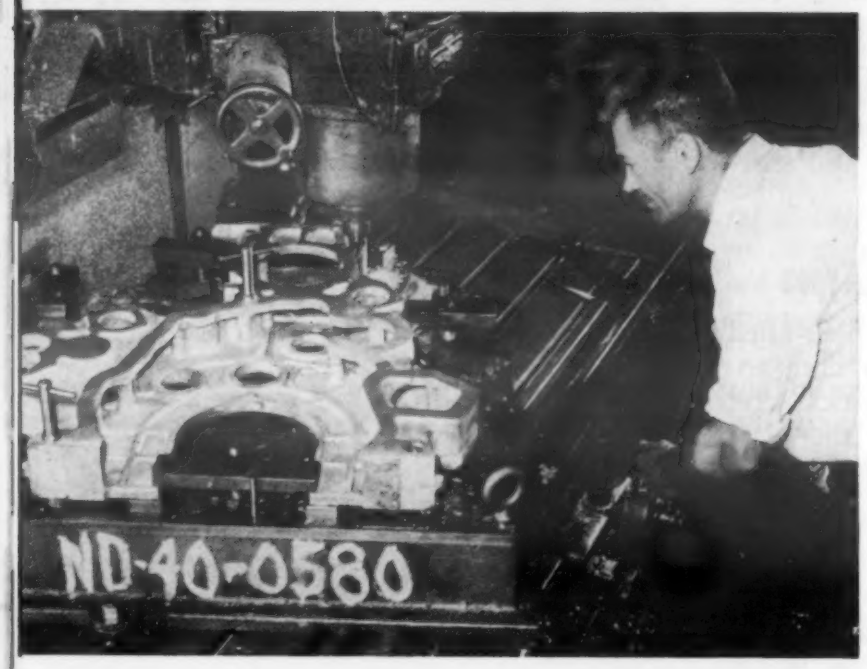
Materials at Work

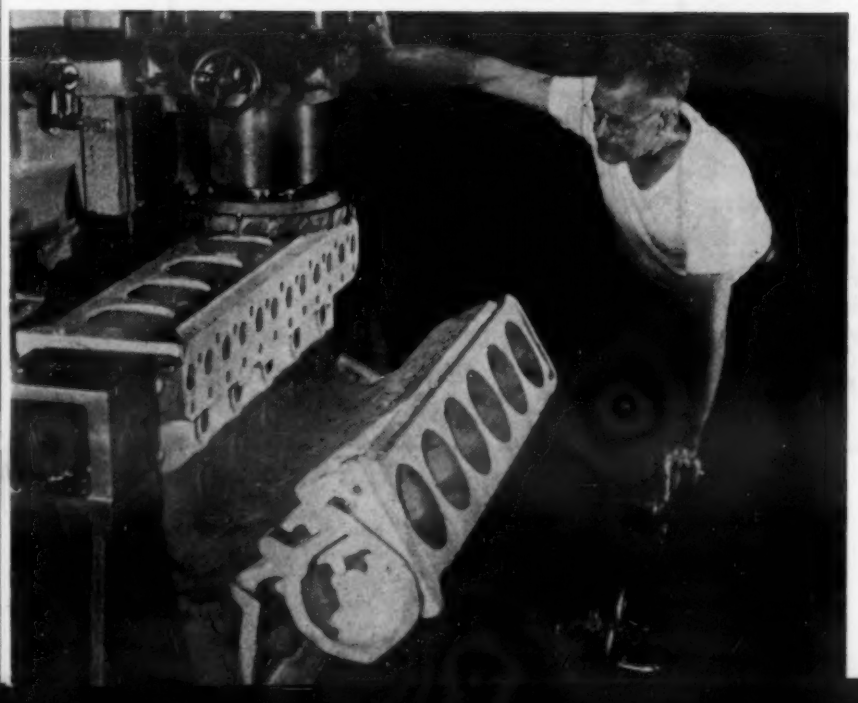
Here is materials engineering in action . . .

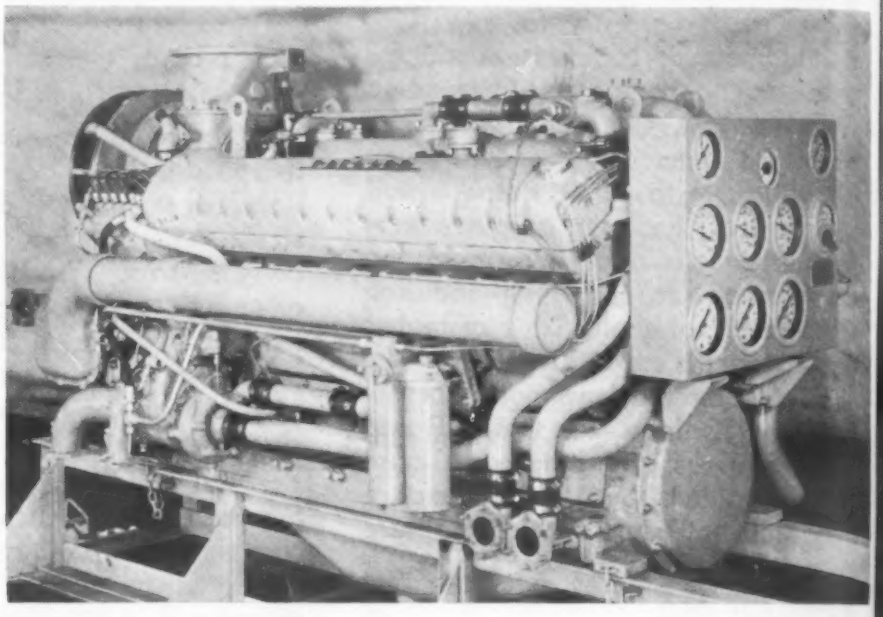
New materials in their intended uses . . .

Older, basic materials in new applications . . .









ALUMINUM DIESEL BODY CASTINGS A series of lightweight diesel engines now being built for the U. S. Navy shows interesting use of lightweight alloys in the principal structural parts. Packard Motor Car Co. designed and produces the engines.

The two engines now in production are a 6-cylinder, 300-brake hp model and a V-type 12-cylinder model that develops 600 brake hp. The specific weights are the lowest of any diesel now in production, 7.34 lb per bhp and 5.41 lb per bhp for the 6 and 12 cylinders models, respectively.

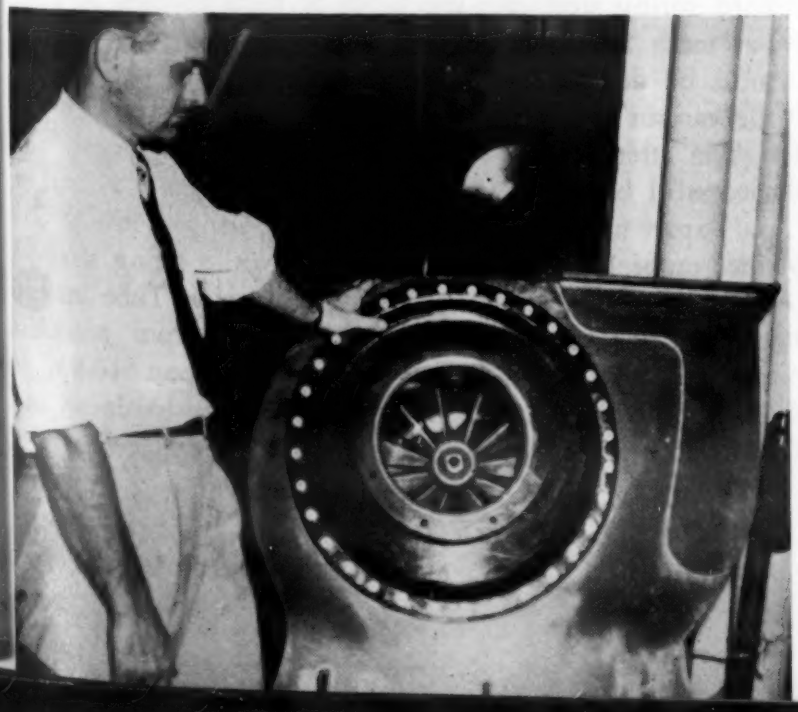
Weight is saved by using aluminum alloy sand castings for all principal parts. The crankcase and cylinder block are one casting. Other large castings are the oil pan, the camshaft housing, the camshaft cover, the accessory gear case, and the flywheel cover. The alloy is N.355. The cylinder head is a steel casting welded to the cylinder barrels. Bronze is used for the bushings, the flywheel, and the sea water pump, and the crankshafts are nickel alloy steel. Pistons are aluminum.

The cylinder block is a massive casting, with heavy bulkheads at the main bearing line to insure rigidity. Pistons are cast in permanent molds. Cylinder heads are precision castings of alloy steel, cylindrical in shape, and fit into bores at the top of the block. They are held in place by threaded plugs. The cylinder heads are welded to wet type cylinder liners, making a removable one-piece assembly. Exhaust valves are sodium cooled, and all valves are faced with Stellite and operate in Stellite seats.

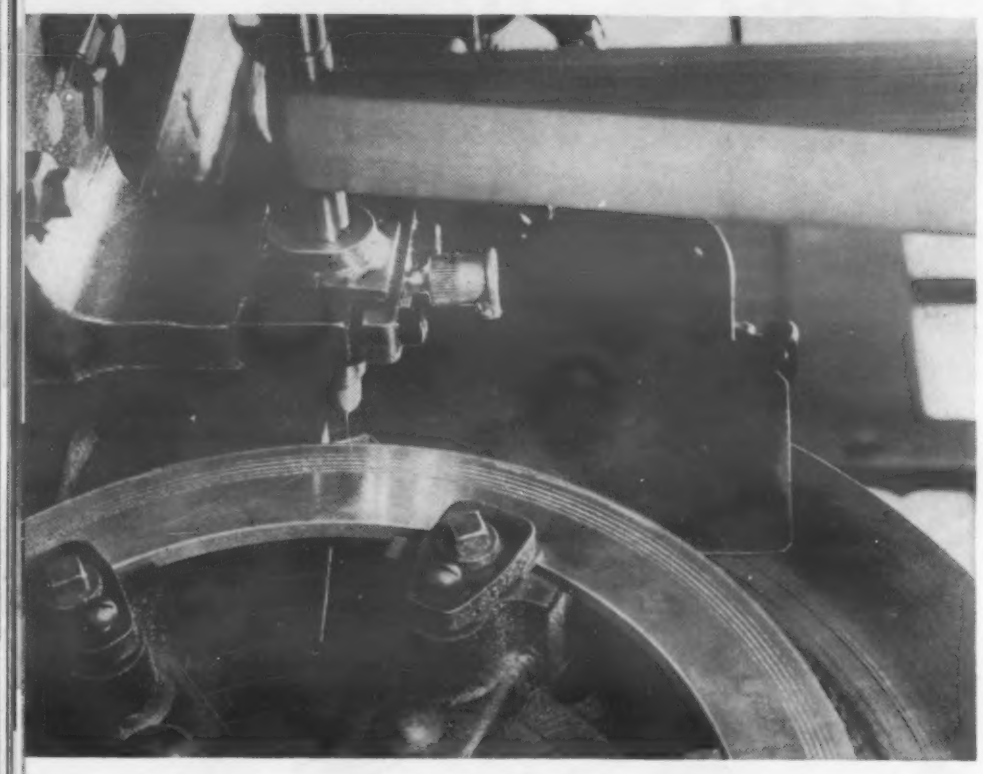
The alloy steel crankshaft is drop forged, counterweighted and balanced, and all journals are nitrided. Main bearings are interchangeable, and are steel-backed with a high-lead and tin coating.

The important weight savings made possible by use of aluminum castings for all the large pieces make these engines valuable militarily, but they promise to make the engines interesting to manufacturers of trucks and buses and off-highway vehicles in the future. Here the reduced weight can be converted into pay load or into lowered operating costs. Other industrial power plants for which portability is a requirement may benefit from the lighter weight also.

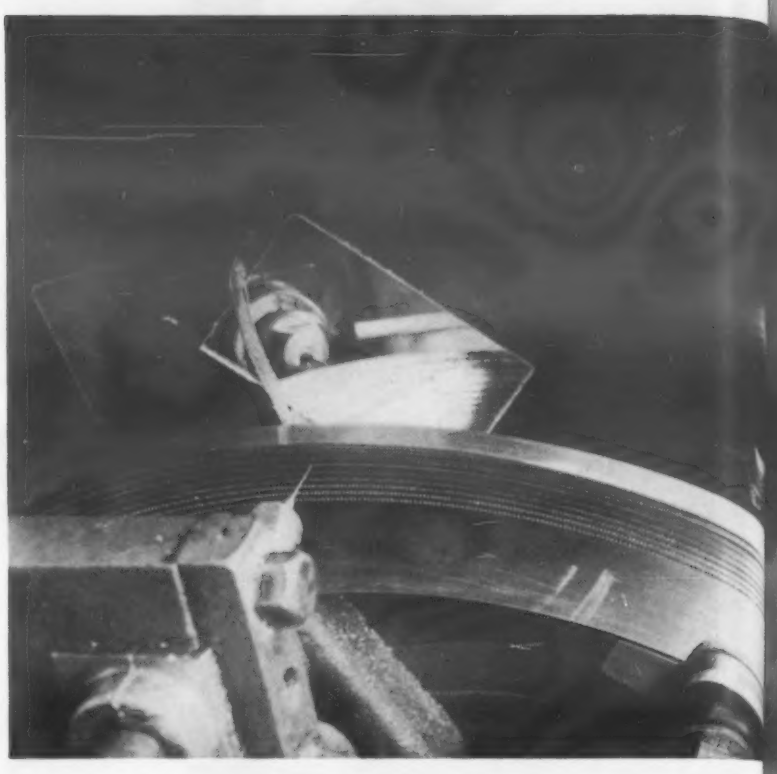
TELLURIUM COPPER ELECTRICAL PARTS Tellurium copper is used in welding and cutting tip products because of its machinability and its high thermal conductivity. Tellurium copper, with machinability approaching that of free-cutting brass and electrical conductivity 90% of that of pure copper, is particularly well suited for the mass production of many electrical and electronic connectors and other parts. The alloy is available from the Chase Brass & Copper Co., subsidiary of Kennecott Copper Corp. The addition of tellurium to pure copper does not materially reduce electrical conductivity, but it does greatly increase ease of machining. The alloy may be extensively hot worked, since the addition of tellurium does not adversely affect the hot working properties of copper. It may also be severely cold worked, although it is somewhat less ductile at room temperatures than pure copper. These properties of tellurium copper provide an important advantage, in comparison with leaded copper or leaded-high copper alloys, because the hot working properties of copper are greatly reduced even when small amounts of lead are added.



RIGID POLYVINYL CHLORIDE FAN This large industrial ventilating fan is made entirely of Lucoflex, an unplasticized, hard polyvinyl chloride material made by American Lucoflex, Inc. Even the blades are made of Lucoflex, and its operation is as efficient as a metal fan. Since the plastic material resists chemical fumes of all types, the life of the fan in electroplating and chemical plants is many times that of metal units. The plastic fan is lightweight, durable and requires a minimum of support when installed.



First . . . Cast alloy rings are precision drilled with concentric rows.



Second . . . Round holes are blanked for pins. Each row takes a different shape pin.

Third . . . Pins are hard set and tapped through for precision of pin length.

Finally . . . Pin-set is used to align spline teeth.

ALLOY TUBE PIN-SETS Metallurgical and design engineers of the Superior Tube Co., with production men at the R. H. Hood Co., have developed special pin-sets, used for precision aligning of spline teeth in the manufacture of comb circles for the worsted yarn industry. Hood craftmen had previously tried pin-sets made from umbrella ribs, without success.

Hood comb circles are heavy cast alloy rings, through which a series of concentric circles of holes are bored. Each row of holes is drilled and blanked to carry teeth of a different cross sectional shape. Spring steel spline teeth are inserted through the ring to form a circular comb.

Each tooth is hand-aligned by slipping the preshaped pin-set over the tooth and bending it straight. This operation requires perfect pin-set fit over the entire length of the comb tooth. Since the comb teeth are made of very hard spring steel, pin-sets must be hard enough to bend the teeth for aligning. At the same time, the pin-sets must be ductile enough to allow shaping of tips to fit the various tooth shapes.

The attempt to adapt umbrella ribs were largely unsuccessful because that type of seamed tubing tended to pull apart at the seams. In addition, many of the makeshift umbrella rib pin-sets snapped while being shaped.

After careful experimentation, Superior Tube metallurgists suggested making the pin-sets from seamless tubing. Research indicated that high-carbon (0.95 to 1.10%) AISI E-52100 alloy provided the hardness and exceptionally high tensile strength necessary.

VINYL SAFETY LINK A new type automatic gas cut-off valve developed by the Kelly Safety Device Co. is designed for use with natural and manufactured gas, and is primarily intended to be placed on a building's gas supply line in front of the gas meter. In event of a fire, a fusible link, made of B. F. Goodrich Chemical Co.'s Geon 404 plastic, distorts at approximately 165 F, forcing a tension spring to close the valve. This will prevent the discharge of gas from a melted gas meter.

Valves now in common use must be shut off by hand. This is often impossible to do because of the excessive heat, smoke and fumes that accompany fire. The Kelly-Byrne valve is an automatic closing valve with ground metal to metal seating and proper openings for gas to pass through freely. The valve stem is held in an open position by the plastic link. When excessive heat comes in contact with the plastic, the link spreads, breaks, or becomes elastic enough to allow the stem to spring to its closed position, positively cutting off the flow of gas. Replacement links return the valve to perfect operating condition.

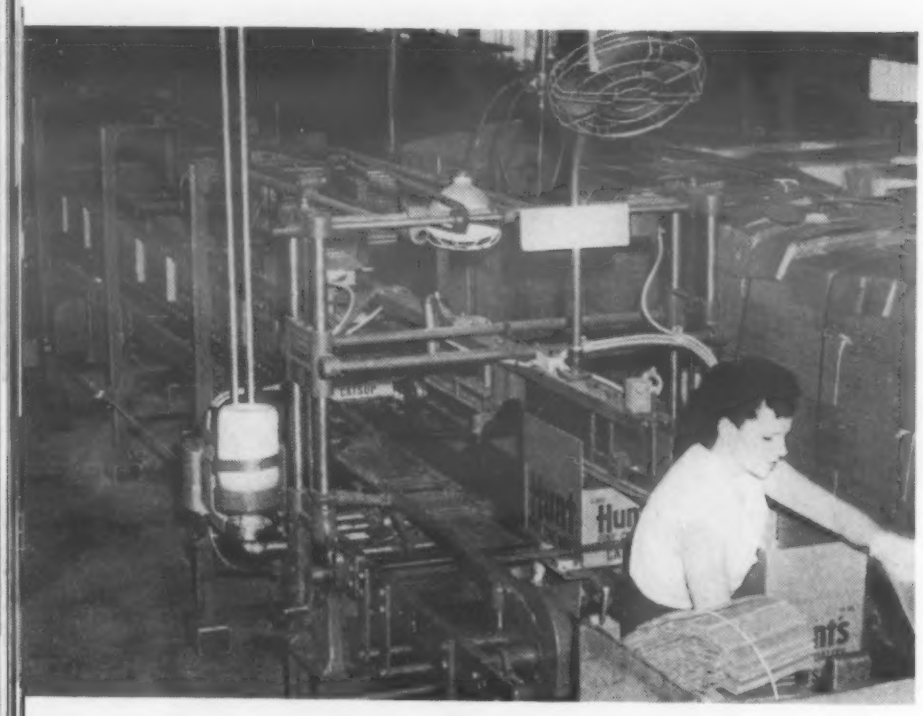
Having Underwriters' Laboratories' approval, the valve's most important part is the plastic link made from Geon 404 rigid unplasticized polyvinyl chloride resin. All other plastics tested were subject to "creep" or flow, which defeated the purpose of the thermo-plastic idea. However, plastic links made from Geon 404 were tested and subjected to a temperature of 125 F for months and no creep or deformation could be observed. The average operating time for the valve to close at 200 F is approximately 2½ min.

MONEL RELIEF VALVE PARTS At a government chemical plant at Wilson Dam, Ala., relief valves in one process stream system protect themselves while on the job. The solution in this system is so corrosive that the internal parts of conventional relief valves would become inoperative in a very short time.

The engineers at Vitro Corp. of America, which planned this installation, solved half of the corrosion problem by specifying a specialized type of relief valve. Called the FarriSeal, this valve is protected by a metal bellows which seals off internal parts and spring chamber from the corrosive stream. This arrangement also cuts down the effects of back pressure and eliminates the need for bonnet venting.

Vitro's engineers solved the rest of the problem by specifying solid monel valve bodies as well as monel bellows, nozzle, disk and disk holder. All parts contacting the stream are made of monel, an alloy which proved sufficiently corrosion resistant for the application. Monel is supplied by International Nickel Co., Inc.

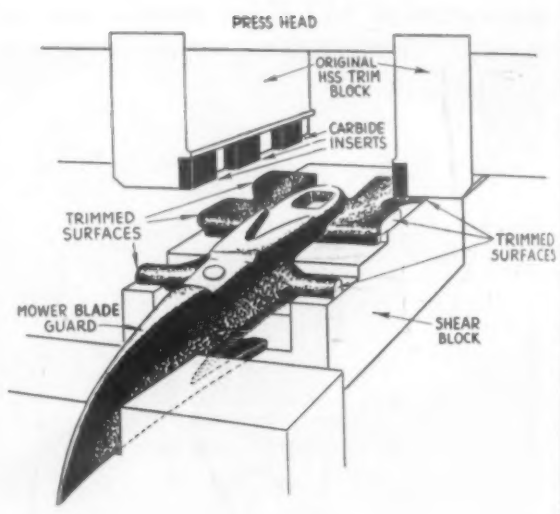
Materials at Work



POLYETHYLENE GLUE BOTTLE United Can & Glass Co. has adopted the polyethylene bottle as a glue feeder on a machine that seals catsup bottle cartons. Danger of smashing the bottle when struck accidentally is eliminated. With the glass bottle previously used, operators might smash the container when taking it out of position and refilling. In addition to being lighter and easier to handle, the bottle, which is in an exposed position on the machine, will not break if accidentally struck with a tool or a materials handling machine. Its mouth cannot be chipped and always provides a perfect seal. The material is relatively soft and will not ridge a gasket at any connecting point and thus cause leakage. The container is blow-molded in one piece by Plax Corp.

FORGED STEERING KNUCKLE AND PIN The problem facing the Towmotor Corp. was to simplify production of the steering knuckle and pin assembly used on Towmotor Fork Lift Trucks. It was decided to redesign the forged knuckle, simplifying its shape to get greatest advantage from the strength improvement which results from proper positioning of grain flow. It was then possible to weld the pin to the knuckle, eliminating machining operations on both knuckle and pin, and also producing a unit assembly which would not loosen in service.

CEMENTED CARBIDE TRIM BLOCK INSERTS Successful use of shear blocks of cemented carbide for trimming of flash from steel castings in production is reported by the Oliver Corp. The blades are used on a progressive die in a crank press in which mower blade guards are, respectively, pierced, riveted and trimmed. The die originally had two steel trim blocks, one on each side of the die, to simultaneously shear six faces varying in length from 1/4 to 5/8 in., three on each side of a SAE 1045 casting. Tool life of the trim blocks was comparatively short and they had to be changed at the end of each day (12,000 pieces). The use of cemented carbide, made by the Carboloy Dept. of General Electric Co., on the cutting edges of the trim blocks proved to be the answer.



The original trim blocks were altered to receive the inserts by grinding a step in each. The inserts, of tungsten carbide, were then brazed on the steps at intervals along each block to correspond with the casting faces to be sheared. The blow is taken on the 1/4-in. face of the inserts. Because the parts are not stripped, there is a 1/64-in. over-hang of the carbide to provide free clearance to facilitate removing the part before the die head moves back to the top. No difficulty has been encountered from this supported over-hang. With the carbide blocks, tool life of the shearing die has been increased to well over 100,000 pieces between grinds. Very little grinding is needed at the time of sharpening, and there has been no sign of the cutting edges being chipped or broken under the continuous impacts.

12 Important Buying Rules

1. Carefully estimate the number required and the rate of production so that the most economical casting method can be chosen.

2. Determine the mechanical and physical requirements of the part so that the proper alloy can be selected which will also be suited to the casting method.

3. Request bids from several foundries of good reputation that have the experience and facilities to furnish castings of the type desired at the required production rates.

4. Submit detailed drawings and a model or test pattern when available; if a reorder, submit sample casting as it was previously made.

5. Specify service conditions in detail, especially any points of high stress or pressure-tightness, if required. Indicate machining locating points.

6. Ask prospective suppliers if they have control equipment, inspection procedures, and laboratory facilities to assure the attainment of specified physical and mechanical properties consistently.

7. If the casting requires a high-strength alloy, ask prospective suppliers if they have adequate heat treating equipment with accurate temperature control.

8. If possible, investigate the experience of other customers with prospective suppliers.

9. After a supplier has been tentatively selected, visit him and see for yourself whether he has the sort of plant where you would like your castings to be made.

10. Don't give your order to the lowest bidder unless you are satisfied that he will produce good quality castings at the lowest over-all cost. Sometimes difficulties with machining and finishing and in adjusting rejects will wipe out any apparent savings.

11. After choosing a supplier, provide for the fullest possible consultation and collaboration between your design engineers and his technical personnel.

12. Give careful consideration to any changes the foundryman suggests that might simplify production, reduce cost, or result in better castings.

How to Buy Aluminum Castings

by FLOYD A. LEWIS, The Aluminum Association

Which shall it be: a sand, permanent mold, or die casting? Selection rests on consideration of (1) engineering properties, (2) cost, (3) design possibilities, and (4) production rates obtainable with each type.

● Selecting and buying the best and most economical aluminum casting for any given application is not a difficult job, but it does require that attention be given to a number of specific considerations. A good procedure to follow is outlined in the list of 12 rules given above. These 12 steps are not always followed in exactly the order listed, and sometimes there is overlapping between two or more steps. But all of these points should be given careful consideration, especially if the castings involve any unusual features.

If the part to be cast is a simple one involving no special requirements or high mechanical strength, the purchase is greatly simplified.

Table 1—Composition of Commercial Aluminum Casting Alloys

Alloy Designation		Nominal Composition, %, Bal. Aluminum						Heat Treatable	Sand, Perm. Mold, or Die
New	Old	Copper	Silicon	Magnesium	Zinc	Nickel	Others		
C4A	C1	4.5	—	—	—	—	—	Yes	S
CG100A	CG1	10.0	—	0.25	—	—	—	Yes	S&P
CN42A	CN21	4.0	—	1.5	—	2.0	—	Yes	S&P
CS42A	CS4	4.5	2.5	—	—	—	—	Yes	P
CS43A	CS5	4.0	3.0	—	1.0	—	—	Yes	S
CS104B	CS21	10.0	4.0	1.0	—	1.0	—	No	P
CS72A	CS22	7.0	2.5	—	2.5[2]	—	—	No	S&P
CS66A	CS23	6.5	5.5	0.4	—	—	—	Yes	P
G4A	G1	—	—	4.0	—	—	—	No	S
G8A	G2	—	—	8.0	—	—	—	No	D
G10A	G3	—	—	10.0	—	—	—	Yes	S
GS42A	GS1	—	1.8	4.0	—	—	—	No	S&P
GZ42A	GZ1	—	—	4.0	1.8	—	—	No	P
S5A	S1[3]	—	5.0	—	—	—	—	No	S&P
S5B	S2[3]	—	5.0	—	—	—	—	No	S&P
S5C	S4[3]	—	5.0	—	—	—	—	No	D
S12A	S9[4]	—	12.0	—	—	—	—	No	D
SC64A	SC1	4.5	5.5	—	—	—	—	No	P
SC54A	SC2	3.5	5.0	—	—	—	—	No	D
SC54B	SC5[4]	3.5	5.0	—	—	—	—	No	D
SC84A	SC6[4]	3.5	8.5	—	—	—	—	No	D
SC84B	SC7	3.5	8.5	—	—	—	—	No	D
SC64B	SC8	3.7	6.3	—	1.0[2]	0.5[2]	—	Yes	S&P
SC64C	SC9	3.7	6.3	0.5	1.0	0.5	0.8 Mn	Yes	S&P
SC51A	SC21	1.3	5.0	0.5	—	—	—	Yes	S&P
SC122A	SC41	1.5	12.0	0.7	—	—	0.7 Mn	Yes	P
SC82A	SC42	1.5	7.8	0.4	—	0.2	0.4 Mn	Yes	S
SG70A	SG1	—	7.0	0.3	—	—	—	Yes	S&P
SG100A	SG2[4]	—	9.5	0.5	—	—	—	No	D
SN122A	SN41	1.0	12.0	1.0	—	2.5	—	Yes	P
ZG61A	ZG41	—	—	0.6	5.5	—	0.5 Cr	Yes	S

1. *From specifications of American Society for Testing Materials.*
2. *Maximum Values.*
3. *Alloys S5A and S5B are identical except that impurities in S5A are held to lower limits, giving it greater resistance to corrosion. S5C is a similar alloy for die casting.*
4. *Impurities in these die casting alloys are more closely controlled than in the other die casting alloys of otherwise identical composition. These alloys can be cast only in cold-chamber machines.*

Almost any foundry that can produce castings of good appearance may be selected. Any complications in the design or in structural or other requirements, however, must be given careful attention if difficulties are to be avoided. Except for the simplest parts, it is not wise to buy on the basis of bid price alone as any one of a number of possible difficulties may wipe out any apparent saving in purchase price.

The first thing the purchaser must do is to estimate how many units will be required as this will largely determine the casting process to be used. He must then ascertain the mechanical and physical requirements that the part must meet so that a suitable alloy can be chosen. These steps are closely interrelated because only certain alloys are adaptable to each of the various casting methods.

Other factors that will influence choice of casting process are size and shape of the part, minimum sectional thickness, dimensional tolerances, surface finish, and relative machining and finishing costs.

Choosing the Kind of Casting

About 90% of all aluminum castings now being produced are made by either the sand, permanent mold, or die casting processes. A comparison of these methods is given in Table 2.

Sand casting is the most flexible of the three methods and is generally employed for large or intricate castings and for castings of all types and sizes where the quantity to be produced will not justify the construction of a metal mold or die. Sand casting also is used for longer production runs of small and medium-sized parts of a design suitable to modern high-speed molding equipment where costs lower than for other methods can be established.

Both permanent-mold and die-casting processes are inherently mass-production methods. They are, therefore, particularly useful where large numbers of identical castings are to be produced. No specific lower limit can be established at which these processes become economical. Usually several thousand units must be required to make either process feasible, although as few as 500 have been produced economically in special cases.

In general, permanent mold castings have higher mechanical properties, greater uniformity, smoother surfaces, closer dimensional tolerances, and better pressure tightness than sand castings. By taking full advantage of these factors, castings made by this method will usually require less metal for the same design stress than sand castings. The smoother surfaces and closer dimensional tolerances mean lower machining and finishing costs.

Many designs that are too intricate to be produced from a practical standpoint by the full permanent mold process can be successfully cast using iron molds and sand cores. This combination results in what is known as the semipermanent mold method, extending the flexibility of the permanent mold process while retaining many of its advantages.

Ability to cast thin sections, accuracy, uniformity of reproduction, and low unit cost characterize the die casting process. In reproduction of surface detail and surface finish, die casting is superior to any other method. The thinner sections possible with this method permit substantial savings in metal. The dimensional accuracy, smooth surfaces, and ability to cast threads and core holes contribute to minimum finishing cost.

Sand castings weighing from a few ounces up to 1500 lb are commonly produced, and castings up to 7000 lb have been made. Permanent and semipermanent mold castings from a few ounces to 300 lb in weight are in regular production, but permanent mold castings weighing up to 500 lb have been produced. For die castings, the weight range is from a fraction of an ounce up to about 20 lb. Castings having overall dimensions up to 36 by 12 by 9 in. are being produced, but the dimensions in one direction may exceed these, die castings up to 84 in. in length having been produced.

A few parts can best be produced by other methods, such as the plaster mold process, investment or "lost wax" method, and centrifugal casting. Parts requiring smoother sur-

Table 2—Comparison Between Sand, Permanent-Mold and Die Castings

Ratings 1, 2 and 3 indicate the relative advantages of the three methods for each factor, number 1 being the most advantageous.

Property	Sand Castings	Permanent-Mold Castings	High-Pressure Die Castings
Strength	2	1	2 (a)
Structural Density	2	1	3
Reproducibility of Successive Castings	3	2	1
Pressure Tightness (After Machining)	2	1	2
Cost per Piece (b)	3	2	1
Speed of Production (b)	3	2	1
Flexibility as to Alloys	1	2	3
Tolerances	3	2	1
Flexibility of Design	1	2	3
Size Limitation	1	2	3
Surface	3	2	1
Speed of Getting into Production	1	2	2
Pattern or Mold Cost	1	2 (c)	3 (d)
Thickness of Section	3	2	1

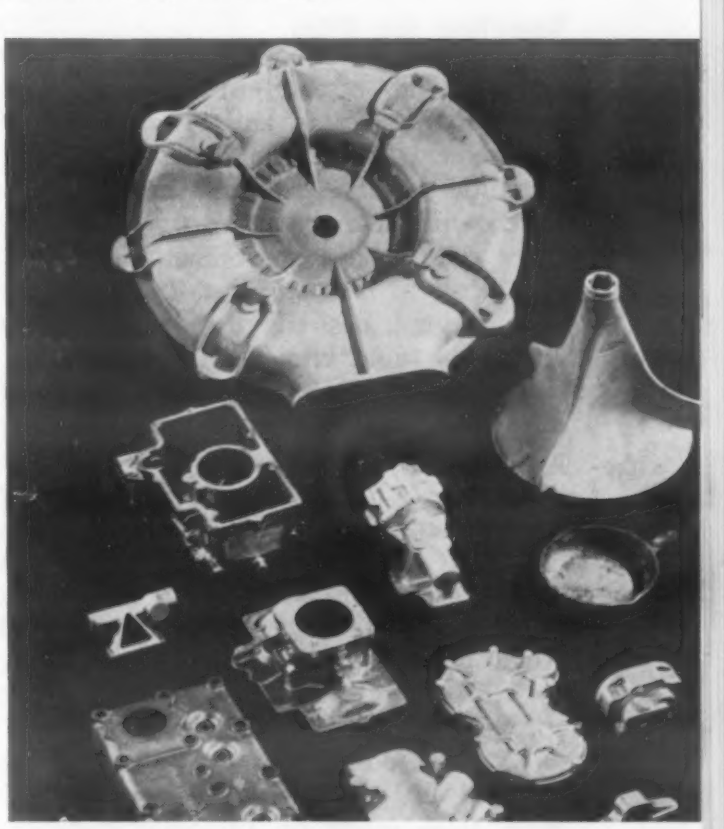
(a) Thin die castings of uniform section may have first classification in the "as cast" condition.
(b) Although this rating covers the majority of castings, in some cases either sand or permanent-mold castings may take first place.
(c) The cost of permanent-mold equipment may be equal to or less than production sand-cast equipment for large or complicated castings adaptable only to these two processes.
(d) The cost of dies plus the cost of tooling for machining or finishing is frequently less than the same over-all cost for sand or permanent mold castings.

Table 3—Classification of Aluminum Casting Alloys by Type of Application

Application	Casting Method		
	Sand	Permanent Mold	Die
General-Purpose Alloys	C4A CS43A SC64B SC64C ZG61A	CS42A SC64B SC64C	S12A SC54A SC84B SG100A
General-Purpose Alloys Where Pressure Tightness Is Required	CS72A S5A SC51A SG70A	CS72A S5A SC64A SC51A SG70A	SC84B SG100A
Alloys for Architectural and Decorative Purposes	S5A G4A GS42A SG70A	S5A GS42A GZ42A SG70A	G8A S12A SG100A
Alloys with High Resistance to Corrosion	S5A S5B G4A G10A GS42A SG70A	S5A S5B GZ42A SG70A	G8A S5C S12A SG100A
Alloys Retaining Strength at Elevated Temperatures	CG100A CN42A SC51A SC82A	CG100A CN42A SN122A SC51A CS104B SC122A	SC84A SC84B SG100A
Piston Alloys	CG100A CN42A	CG100A CN42A CS66A SN122A SC122A	SC84B

When service temperatures are above 600 F, die castings may develop surface blisters.

Aluminum alloy die castings



Aluminum alloy permanent mold castings

Aluminum alloy sand casting

faces and greater accuracy than can be obtained with any of the three principal processes can be successfully cast in plaster molds. The investment process is also capable of great accuracy and is sometimes used for very small complicated parts that can be produced in groups or clusters.

If the part to be produced requires the use of one of these specialized methods, it is best to discuss the problem directly with one or more of the foundries using the particular method in question. Since these foundries are relatively few in number, their selection is comparatively easy.

Selecting the Alloy

After the casting method best suited to the design and production requirements has been determined, an alloy suitable for that method which will have the necessary properties can be chosen. Sometimes it is difficult to find an alloy that will have all the desired characteristics. Often the final choice will narrow down to one representing the best compromise between two or more conflicting factors.

Commercial aluminum casting alloys in common use today are listed in Table 1. Their mechanical properties are given in Table 4. In Table 3 these alloys are grouped by the broad general types of applications for which they are most suitable. In applying the values given in Table 4 to an actual design, it must be borne in mind that those values are based upon tests made on carefully cast test bars. In some castings these characteristics may not be fully realized. For example, in castings involving thick sections the unit mechanical strength will be lower than that shown by the test bars. Likewise, in castings having thinner sections the unit mechanical strength may be higher than in the separately cast test bars.

The first decision to be made in choosing an alloy is whether one not requiring heat treatment will provide the necessary mechanical and other properties, or whether a heat treated alloy will be required. As shown in Table 4, heat treatment increases the strength, but often lowers ductility. Die-casting alloys are not usually given any heat treatment except aging treatments at relatively low temperatures.

Although tensile strength is perhaps the most significant single mechanical characteristic to be considered, an alloy should not be chosen on the basis of that property alone. Yield strength, elongation, hardness, and compressive, shear and fatigue strengths are other mechanical characteristics that may be significant in any particular application.

Attention must also be given to casting qualities. For simple designs where high strength is not a factor, casting qualities do not require any special consideration; but if the design is complicated or if the castings must be pressure tight, an alloy having good casting qualities should be used.

If the castings will be exposed to corrosive elements, such as acids or salt water, then an alloy having high resistance to corrosion should be used. Machinability is a characteristic that should receive careful consideration for castings requiring considerable machining. While ease of machining and finishing is one of the outstanding characteristics of aluminum castings in general, some alloys machine easier than others.

Where the castings must retain their strength at elevated temperatures, such as those used in internal-combustion engines, one of the alloys possessing this characteristic must be used. Some engine parts require good resistance to wear in addition to high strength at elevated temperatures. Pistons, for example, require this combination of properties plus good casting and machining characteristics.

Alloys containing copper and silicon, either singly or together, or in combination with smaller amounts of other elements, comprise the groups that are most widely used for the great bulk of aluminum casting production. In addition, these alloys cover a wide range of mechanical properties so that they are useful as well for some of the more specialized purposes.

The aluminum-copper-silicon alloys have better casting characteristics than the aluminum-copper alloys, but are not as resistant to corrosion as the aluminum-silicon series. The copper content provides strength and hardness while the silicon content improves the casting qualities and increases the resistance to corrosion. These alloys are particularly well adapted to casting work involving intricate design, having large differences in section thickness, or requiring pressure tightness. Excellent casting characteristics also are found in the aluminum-silicon alloys, together with higher resistance to corrosion. For these reasons there is an increasing trend toward the use of aluminum alloys in which silicon is a major alloying element. Although the machining of these alloys is more difficult than that of many other aluminum alloys, the problem is simplified by proper technique, tools and lubricants.

Pressure tightness, strength, corrosion resistance and castability are the outstanding attributes of aluminum silicon-magnesium alloys. When heat treated they have tensile properties comparable with those of the aluminum-copper alloys. They are outstanding for all types of service requiring high-quality castings, especially those of intricate design.

The aluminum-silicon and aluminum-magnesium alloys stand highest on the list in corrosion resistance, and the aluminum-silicon series has excellent casting characteristics which enable them to reproduce faithfully fine design details. The aluminum-magnesium series has higher resistance to corrosion but the casting qualities are not as good.

Aluminum-silicon alloys are widely used in marine work because of their excellent resistance to salt water and salt-laden atmospheres. Although the aluminum-magnesium series is much more corrosion resistant, these alloys are not used so widely because of their difficult casting characteristics. By adding other elements, such as silicon or zinc, the casting properties are somewhat improved. The aluminum-silicon alloys, however, are superior in mildly acid solutions such as those found in the textile industry. Both series find extensive applications in the food handling and chemical industries.

Many special-purpose alloys have been developed for applications where specific characteristics are desired. Their usefulness, however, usually is limited to the particular applications for which they are designed. Typical of these highly specialized alloys is a binary alloy containing 2% manganese which has high resistance to slightly acid solutions and has excellent ductility. It has limited use because of its difficult casting characteristics.

Controlled electrical conductivity is required in some electrical equipment. When maximum conductivity is required, controlled compositions of essentially pure aluminum are used. Where the design permits slightly lower conductivity, the addition of 1.5% silicon materially improves the casting qualities. Where low electrical conductivity is neces-

Table 4—Mechanical Properties of Aluminum Casting Alloys (Typical Values)

Alloy (ASTM Design.)	Condition[1]	Tension[3]			Compression[6]	Hardness[3]	Shear	Fatigue
		Yd. St. (Set = 0.2%), Psi	Ult. St., Psi	Elong., % in 2 In.	Yd. St. (Set = 0.2%), Psi	Brinell, 500-Kg. Load, 10-Mm Ball	Shear St., Psi	Endurance Limit[5], Psi
C4A	Sol. treated (S)	16,000	32,000	8.5	16,000	60	24,000	6,000
C4A	Sol. treated and aged (S)	30,000	40,000	2.0	38,000	95	31,000	7,000
CG100A	Annealed (S)	20,000	27,000	1.0	20,000	80	21,000	9,500
CG100A	Sol. treated and aged (S)	30,000	40,000	0.5	43,000	115	29,000	8,500
CG100A	Artificially aged (P)	35,000	37,000	0.5	40,000	115	27,000	8,500
CG100A	Sol. treated and aged (P)	36,000	48,000	0.5	36,000	140	30,000	9,000
CN42A	Annealed (S)	18,000	27,000	1.0	18,000	70	21,000	6,500
CN42A	Sol. treated and aged (S)	25,000	28,000	2.0	—	75	24,000	9,500
CN42A	Artificially aged (P)	34,000	40,000	1.0	34,000	105	26,000	10,500
CN42A	Sol. treated and aged (P)	42,000	47,000	0.5	46,000	110	31,000	9,500
CS42A	Sol. treated (P)	22,000	37,000	9.0	22,000	75	30,000	9,500
CS42A	Sol. treated and aged (P)	26,000	40,000	5.0	26,000	90	32,000	10,000
CS42A	Sol. treated and aged (P)	20,000	39,000	4.5	20,000	80	—	—
CS43A	As cast (S)	14,000	19,000	1.5	—	—	—	—
CS104B	As cast (P)	24,000	32,000	1.5	32,000	100	22,000	—
CS72A	As cast (S)	15,000	24,000	1.5	17,000	70	20,000	9,000
CS72A	As cast (P)	19,000	28,000	2.0	19,000	70	23,000	—
CS66A	Artificially aged (P)	16,000	29,000	1.0	16,000	95	22,000	—
G4A	As cast (S)	12,000	25,000	9.0	12,000	50	20,000	5,500
G8A	As cast (D)	27,000	45,000	8.0	27,000	—	27,000	23,000
G10A	Sol. treated (S)	25,000	46,000	14.0	26,000	75	33,000	7,000
GS42A	As cast (S)	13,000	20,000	2.0	15,000	50	17,000	—
GZ42A	As cast (P)	16,000	27,000	7.0	17,000	60	22,000	—
S5A	As cast (S)	9,000	19,000	6.0	10,000	40	14,000	6,500
S5B	As cast (S)	9,000	19,000	6.0	10,000	40	14,000	6,500
S5A	As cast (P)	9,000	24,000	9.0	9,000	45	18,000	—
S5B	As cast (P)	9,000	24,000	9.0	9,000	45	18,000	—
S5C	As cast (D)	16,000	30,000	9.0	16,000	—	19,000	17,000
S12A	As cast (D)	21,000	39,000	2.0	21,000	—	25,000	19,000
SC64A	As cast (P)	16,000	28,000	2.0	16,000	70	25,000	—
SC54A	As cast (D)	24,000	40,000	5.0	24,000	—	26,000	22,000
SC54B	As cast (D)	22,000	38,000	5.5	22,000	—	25,000	22,000
SC84A	As cast (D)	25,000	46,000	3.0	25,000	—	29,000	19,000
SC84B	As cast (D)	26,000	45,000	2.0	26,000	—	29,000	20,000
SC64B	As cast (S)	18,000	27,000	2.0	18,000	70	—	10,000
SC64B	Sol. treated and aged (S)	24,000	36,000	2.0	24,000	80	—	10,000
SC64B	As cast (P)	19,000	34,000	2.5	19,000	85	24,000	—
SC64B	Sol. treated and aged (P)	27,000	40,000	3.0	27,000	95	—	—
SC64C	As cast (S)	18,000	23,000	--	—	—	—	—
SC64C	Sol. treated and aged (S)	24,000	31,000	1.5	—	—	—	—
SC64C	As cast (P)	19,000	26,000	—	—	—	—	—
SC51A	Artificially aged (S)	23,000	28,000	1.5	24,000	65	22,000	7,000
SC51A	Sol. treated and aged (S)	25,000	35,000	2.5	29,000	80	30,000	8,500
SC51A	Sol. treated and aged (S)	29,000	35,000	1.5	—	75	—	10,000
SC51A	Sol. treated and aged (P)	27,000	43,000	4.0	27,000	90	30,000	9,000
SC122A	Sol. treated (P)	27,000	41,000	2.5	27,000	90	—	—
SC122A	Artificially aged (P)	26,000	40,000	0.3	26,000	97	—	—
SC122A	Sol. treated and aged (P)	38,000	43,000	1.0	38,000	92	—	—
SC82A	Sol. treated and aged (P)	40,000	49,000	3.0	—	97	—	—
SC82A	Sol. treated (S)	20,000	33,000	2.9	20,000	82	—	—
SC82A	Sol. treated and aged (S)	28,000	36,000	2.0	28,000	81	—	—
SG70A	Artificially aged (S)	20,000	25,000	2.0	22,000	60	18,000	7,500
SG70A	Sol. treated and aged (S)	24,000	33,000	4.0	24,000	70	27,000	8,000
SG70A	Sol. treated and aged (P)	27,000	40,000	5.0	24,000	90	—	—
SG100A	As cast (D)	27,000	44,000	3.0	27,000	—	28,000	19,000
SN122A	Artificially aged (P)	28,000	36,000	0.5	28,000	105	24,000	—
SN122A	Sol. treated and aged (P)	43,000	47,000	0.5	43,000	125	27,000	—
ZG61A	Artificially aged (S[2])	25,000	32,000	3.0	25,000	75	26,000	9,000

1. In these columns S denotes specimen cast in green sand; P denotes chill-cast specimen having properties similar to a permanent or semipermanent mold casting; D denotes die cast specimen.

2. May be aged at room temperature, or artificially aged at higher temperature.

3. Tension and hardness values determined from standard half-inch diameter specimens individually cast in sand (S) and permanent (P) molds, and tested without machining off the surface. Tension values for die casting alloys determined from standard ¼-in. die cast specimens (D); hardness values are not shown for die castings because they cannot be reliably determined.

4. Yield strength is the stress which produces a permanent set of 0.2% of the initial gage length American Society for Testing Materials Standard Methods of Tension Testing.

5. Endurance limits are based on 500,000 cycles of completely reversed stress using the R. R. Moore type of machine and specimen.

6. Compression tests made on specimens having an l/r ratio of 12.

sary, an alloy containing 6 magnesium, 1.5 manganese and 1.5% nickel can be used.

These special alloys have their place and should be specified when needed, but only when needed. The buyer will obtain castings of lowest cost by keeping his specifications as simple as possible. In other words, a heat treated alloy should not be specified if a non-heat treated one will do. An alloy having difficult casting characteristics should not be selected if one easier for the foundryman to handle will serve.

Soliciting Bids

After the casting process and alloy have been tentatively chosen, bids should be requested from a number of foundries. At least three should be chosen so that the buyer will have reasonable assurance that the foundry finally selected to do the job will be representative.

The most important consideration in selecting bidders is the foundries' reputations as to consistency of quality and service. Foundries having considerable experience in producing the type of casting under consideration should be chosen. It is equally important to be sure that these foundries have the facilities to produce the castings at the required production rate.

Each bidder should be given a detailed dimensional drawing of the part and full information on service conditions. Both the total quantity and required rate of delivery must be specified, for these are important factors in determining costs.

In preparing drawings, all surfaces to be machined should be clearly indicated as well as permissible dimensional tolerances. Close tolerances should be specified only where necessary. Dimensional tolerances can be held much closer in permanent mold than in sand castings, while in die castings still closer tolerances are possible.

If a model or test pattern of the part is available it should be submitted to all bidders. When a reorder is under consideration, a sample casting as previously made should be sent.

Except where a pattern, mold or die is already available, the buyer should be sure that bidders have adequate facilities for designing and producing such equipment. This is especially important if the part is to be made by either the permanent mold or die casting process. In any event, allowances must be made for shrinkage of the metal as it solidifies, for adequate draft so that either the pattern or the casting may easily be removed from the mold (depending upon which process is used), and for finishing where machined surfaces are required. In the interest of accuracy, the main machining locating points should be specified before the pattern, mold or die design is determined.

Service conditions must be specified in detail in order that the foundryman can bid accurately on the production of castings that will meet those conditions. Any points of high stress should be specified as well as pressure tightness, if that is required. If the castings are to be used where corrosive influences are present, these conditions should be clearly and fully described. If temperatures at which the castings will function differ materially from ordinary room temperature, these must be clearly indicated.

Buyers should ask prospective suppliers a number of significant questions about their facilities. Specifically, they should ask the foundries if they have accurate temperature control equipment for proper handling of the metal. They should also ask if the foundries have inspection procedures and laboratory facilities to assure attainment of specified properties in the finished castings.

If the casting to be produced requires a high-strength alloy, the buyer should also satisfy himself as to the foundries' ability to perform heat treatment. Attainment of maximum strength in heat treated castings requires that temperatures in the heat treating furnaces be held within close limits for specified lengths of time. Facilities for rapid quenching also are necessary.

One of the most important matters upon which the buyer should satisfy himself is whether the prospective supplier has a quality control set-up adequate to assure the production of good castings meeting the specifications consistently.

An appropriate quality-control program for a given casting will depend partly on the requirements the casting must meet. For example, some highly stressed castings receive 100% x-ray inspection. Castings that are moderately stressed where failure would not involve loss of life or serious interruption of work would not require 100% x-ray inspection but would be produced under x-ray control. The more normal commercial castings which are under low stress and in nonstructural applications, however, require no x-ray control. A large majority of these castings are entirely satisfactory for their purposes if they meet reasonable visual inspection standards.

For castings that must be leakproof or pressure tight, a pressure test is necessary. Some foundries are equipped for "chalk" or ultraviolet testing to detect cracks or voids *that* are open to the surface. These methods are rarely applied 100% to castings in production. However, they are sometimes valuable in the development of proper foundry procedures for the production of certain types of castings.

Foundries with good quality control set-ups will usually be equipped to perform all of these checks or at least will have facilities at their command for performing them when necessary. A well equipped foundry with adequate quality control also will have laboratory facilities for making both chemical and mechanical tests. Finally, a good quality-control program will be set up so that any production defects that crop up will be quickly remedied.

Collaboration Valuable

Buying aluminum castings thus involves more than just getting several bids and ordering from the lowest bidder. Over-all cost should be the criterion and any indications of possible difficulties, such as in machining and finishing or in adjusting rejects, should be evaluated in determining actual cost of finished castings.

Finally, after a foundry has been selected, the buyer should provide for the fullest possible consultation and collaboration between his designers and the technical personnel of the foundry. This process should begin early enough so that any acceptable changes suggested by the foundry technical men can be incorporated in the final design.

Experienced foundrymen often can suggest changes that do not in any way impair the efficacy of the design or interfere with its proper functioning—yet will greatly simplify production, reduce manufacturing cost, or result in better castings. Reputable foundrymen will offer such suggestions purely in the interest of producing castings that will most economically meet the buyer's needs, and therefore, the buyer should give such suggestions full consideration in preparing his final design.

Iron and Steel

Nonferrous Metals

Nonmetallic Materials

Parts and Forms

Finishes and Coatings

Processing Methods

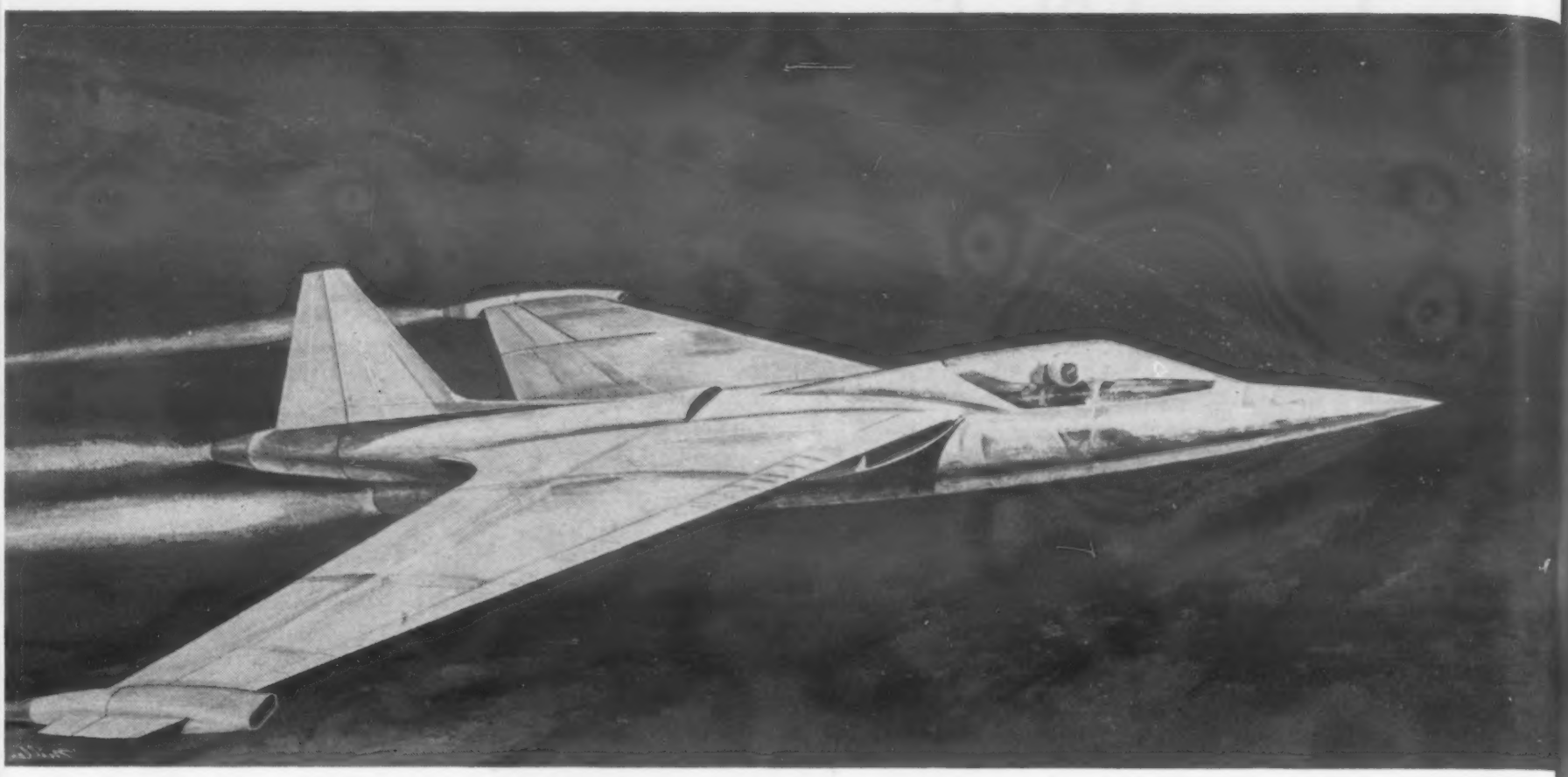
Annual Engineering Materials

Review and Forecast

by T. C. Du Mond, Editor, Materials & Methods

MATERIALS & METHODS
MANUAL No. 90

A quick look at the developments in engineering materials reveals some of the changes in the use of materials that will be forthcoming and the influences that will bring these changes about. Expected are wider uses of titanium and reinforced plastics; an increase in precision forms; larger castings and forgings; and full scale production of hot steel extrusions, among other things.



Here is an artist's conception of a high-speed fighter plane of the future. According to one authority, the answer to ultra supersonic speeds lies in anticipated developments in glass-reinforced plastics.

Introduction

Forecasting is at best a hazardous endeavor. However, it is somewhat easier to see the future in engineering developments than it is to tell what is going to happen in national and international politics. Thus, the major portion of the forecast of this review and forecast will be devoted to technical achievements that are anticipated, based largely on what we have seen in recent months.

It would be foolhardy, indeed, to set forth what is going to happen to raw materials, both as to prices and supplies. No one knows, at this moment, which way the wind will blow six months hence, so any flat, unequivocal prediction would only be a guess.

Our belief is that prices and supplies of many engineering materials will vary during 1953 as they did in 1952. Certain materials will remain scarce and, as a consequence, prices for those materials will remain high, regardless of what happens. New government policies, particularly controls, will have considerable effect upon supplies of the scarce metals.

Official pronouncements of government agencies, as well as predictions by a host of economists, tell us that military production will reach its peak about midyear. After that—and we can take our choice—there will be a mild recession or there will be an upsurge in nonmilitary spending to more than offset a drop in defense expenditures. However, careful analysts feel that business will be strong during the entire year.

Of course, all of the predictions as to prices and supplies can be made worthless should our police action blossom into a full-scale war. Only time, our politicians, and our enemies can tell.

We step upon somewhat firmer ground when we dare to predict what will happen in the field of materials engineering, for many of the dreams of last year will emerge as realities in the year we are now entering. In addition, many materials and processes which have just emerged from the laboratory will be available commercially.

Some of the more important trends in materials, as we see them, are: an increased use of titanium; greater application of magnesium; a continuing swing towards processes and forms which offer greater accuracy; more conversions from metals to nonmetallics, particularly the glass-reinforced plastics; the use of less highly alloyed steels through better heat treatments; larger cast and forged shapes and components; the introduction of hot extruded steel shapes in production quantities; and, the further development of high temperature materials, primarily among the nonmetallics.

Soon to be available is a composite material made by laminating vinyl plastics to sheet steel. A heat and adhesive bond between the two materials is sufficiently strong to withstand mild forming operations and the plastics surfaces are to be capable of serving to protect the steel base against mildly corrosive conditions in service.

More use will be made of laminated and composite materials as more combinations become available. Now there is a selection of many two-metal combinations such as stainless and mild steel, steel and copper, lead and steel, copper and aluminum, plastics and metals, woods and metals. Many thus far untried combinations should become available soon as newer and better bonding methods and adhesives are introduced.

Some of our future worries about supplies of raw materials might be allayed through extension of methods of extracting pure metal powders from ores. Already a new chemical process has been used to obtain nickel, cobalt, copper and manganese oxide. The hope extended by the process is that many deposits of low grade ores of these and other minerals will now

become worth working and thus relieve the United States of its dependence on other areas of the world.

Now let's see what developments of 1952 seem most important as far as materials are concerned. Many of the developments to be described could well be included in a forecast, for although they have been exposed in detail, many will only become generally available during the coming year.

Irons and Steels

Most recent developments in irons and steels have been spurred on by the need to save alloying elements and to obtain strong materials which retain their strength at higher temperatures. It is likely that these two forces will continue to control the direction of research for some time to come. Even though some of the alloying elements that are now scarce become more readily available, wise materials users will try to use lower alloy contents in an effort to keep down the over-all costs of their product.

Comprehensive studies indicate that a low-alloy titanium-boron steel is capable of replacing high alloys in jet and rocket applications. After investigating many alloys, Cornell Aeronautical Laboratories has found that a boron steel with a titanium-to-carbon ratio of 2 to 4, with a carbon up to 0.20% is highly satisfactory. A typical alloy has 3% chromium, molybdenum, titanium and boron. Such an alloy has the strength necessary and is relatively easy to work.

A new ferritic steel of the stainless class has been developed for service between 1000 and 1200 F. The new steel is a modification of Type 420 stainless and is known as Type 422. Maximum hardness can be attained in the new steel from a wide range of temperatures through slow cooling. In addition to iron, the steel contains 0.20 carbon, 0.70 nickel, 13.00 chromium, 0.30 vanadium, 1.00 tungsten and 1.00% molybdenum.

Tempering affects the elevated temperature strength of Type 422 which has a hardness range of 12 to 19 Rockwell C. The steel was originally developed for high temperature bolting, but is also expected to be used for steam turbine blades and other applications in the temperature range up to 1200 F.

The trend toward clad metals of all types continues with the development of a copper-clad steel plate which is intended for applications involving heat transfer, conductivity or corrosion resistance where the strength of steel is needed with the favorable characteristics of copper. Currently it is available only in plate gages with 10, 15 or 20% cladding.

There appears to be more buying of steel on the basis of what the material must do rather than according to exact chemistry. This trend started with the H-steels and seems to finally have taken hold. It is likely that the alloy content of steels for most ordinary uses, even where high strength is needed, will remain low. Makers of such rugged equipment as tractors and other road building equipment have found that by more careful heat treating, finishing and design, mild steels are capable of taking over the jobs once filled by high alloy steels.

Even though there is more nickel being produced today, it seems that shortages of that important element will continue, at least as long as our aircraft program keeps on. Thus, the shift to the straight chromium stainless steels will build up. Type 430 stainless has served as a satisfactory replacement for the 18:8 stainlesses in many applications and more plants are learning how to use it. The precipitation hardening stainlesses are also finding applications. Although they have been available for some years, their acceptance has been somewhat slower than anticipated. One recent application placed the precipitation hardening stainless in a task where extreme strength and good corrosion resistance were necessary. Previously a plated high-strength low-alloy steel had been used.

Perhaps within the next year we will hear of a new high chromium steel with a relatively high manganese content. Early investigations of such a steel indicate that it might have great possibilities in its own right, rather than as a replacement or substitute for standard stainless steels.

Continuous casting and hot extrusion of steels should reach commercial status during 1953. Some mills are finishing installation of equipment now to make tubing of tough materials such as molybdenum, titanium, and tough stainless steels, and solid shapes in alloy steels by hot extrusion. Somewhat akin, at least as far as economy of materials is concerned, is the use of a large draw bench to produce rough hollow forgings up to 35-in. O.D. with 4½-in. walls in rounds, hexagons, octagons and squares with rounded corners. Minimum sizes are 8-in. I.D. with ¾-in. walls. At present, lengths are limited to 22 ft. Equipment limitations restrict the weight of the ingot used to 26,000 lb, thus the other dimensions must follow suit.

Shell molding of both irons and steels should reach a new high during the next year or two, if present indications can be taken as positive signs. With a better understanding of the process and its advantages and limitations, potential users will benefit from the process where savings in machining and finishing will offset the high foundry costs. Stainless steel is now being cast regularly in shell molds, and other ferrous alloys will soon be cast in quantities that rival those of the nonferrous metals.

Nonferrous Metals

Activity among the nonferrous metals continues high and probably will remain so, due largely to the emergence of titanium, zirconium, germanium and other metals which until recently were little more than laboratory curiosities, at least as far as their use as metals was concerned. Too, there is still some rejuggling of applications among the nonferrous metals which results in new and different applications. Here are some of

the developments and trends in specific nonferrous metals groups:

High Temperature Alloys

Late in the year news was made with the release of information on a nickel-chromium-iron alloy which is reportedly good for applications up to 2,200 F. Known as alloy NA22H, the material contains 46.0 nickel, 26.3 chromium, 5.28 tungsten, 1.36 manganese, 0.99 silicon, 0.44% carbon and the remainder iron.

In addition to its high temperature properties, the material is said to have good weldability and thus can be made into large parts. Good creep strength is said to be retained throughout the service range. Uses for the alloy are expected to include radiant tubes for annealing furnaces, retorts for endothermic gas generators, and many parts for various types of industrial furnaces.

Another high temperature material is in the Hastelloy family and is known as Hastelloy X. It differs from its family group in that it has a reduced content of strategic alloys. The alloy contains iron, nickel and molybdenum and uses ferrochromium. Hastelloy X is available in sheet, plate, bar, wire and investment castings.

The new alloy lists among its favorable characteristics good forming properties, good high temperature properties, and high resistance to oxidation. Room temperature ultimate tensile strength is 71,000 psi and elongation in 2 in. is 22%. Chief indicated uses are in aircraft, particularly in jet engines.

Carbides

Although not metals, in the strict sense of the word, carbides are generally considered to fall in the metals class; thus, developments in this field will be discussed here.

Chromium carbide 608 is the first of a new group to be made available commercially. The material has good resistance to erosion and corrosion, plus good abrasion resistance. The density of chromium carbide 608 is ½ that of tungsten carbide. Shapes are machined into the material before sintering. After sintering, it can be ground and joined to other parts by brazing, cementing or mechanically. Among anticipated uses are chemical nozzles and valve components, gages and similar equipment.

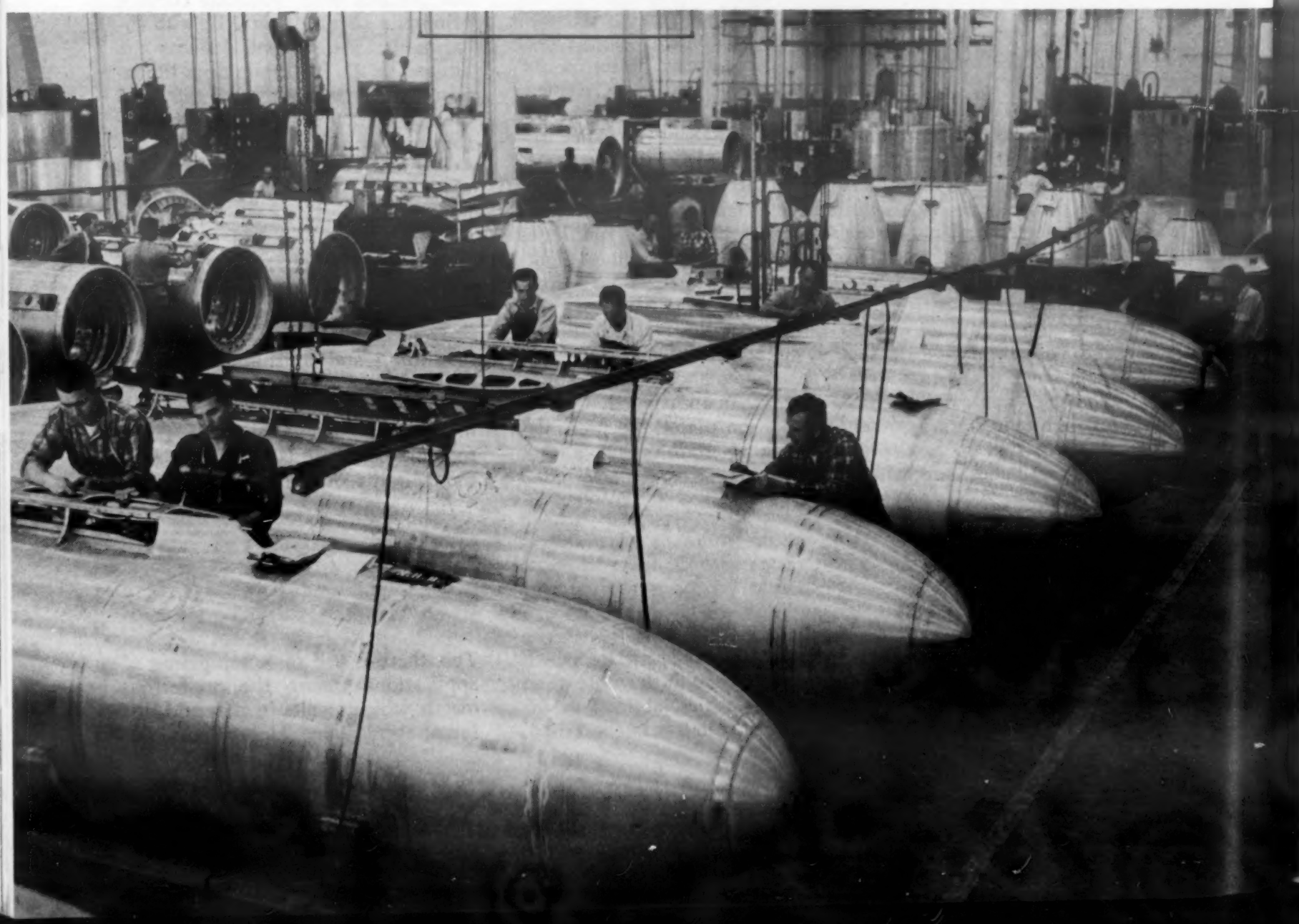
One answer to the search for a high temperature material for jet turbine blades might lie in the use of titanium carbide. This carbide is said to be capable of withstanding the 2,000 + F temperatures anticipated in jet engines. Forming methods have been perfected for titanium carbide which are expected to give the material sufficient strength at high temperatures.

Copper Alloys

With the maze of electronic equipment in present day military aircraft, it is little wonder that the supply of copper remains somewhat below the demand. Due to this condition, efforts are being made to get better use from the available copper rather than to extend its applications. For a while, copper looked upon aluminum as a foe, but now the two metals have become allies. As proof of this, we cite the fact that many of the leading copper producers and fabricators are now dealing in aluminum or have announced their intentions of doing so.

Among the new copper and copper alloy developments are:

Huge airplane fuel tanks are mass-produced for a new jet bomber. The tanks are fabricated of aluminum, and it is estimated that more than 30,000 resistance spot welds are used in each tank, at a rate of 200 spots per min.



A new alloy of copper, nickel and silicon has been produced to make available a copper-base alloy which has high resistance to stress corrosion. The alloy, which also includes iron in carefully controlled quantities, is not susceptible to cracking. Containing 3.5 to 5.0 nickel, 0.7 to 2.0 silicone, and from 0.3 to 1.0% iron, the alloy is used in the cast form. When used in wrought forms, silicon and iron are kept under one-half of the top percentages indicated for the cast alloy. Among the early uses are eyebolts on such equipment as electrical transformers and special types of washers. Other potential uses are under investigation.

In the bronze field, there is a new telnic bronze, an alloy of copper containing tellerium, nickel and phosphorus. The alloy has excellent machinability, good hot and cold workability, good electrical conductivity, high strength, age hardenability, high fatigue strength and good corrosion resistance. It can be hardened by heat treatment. Forging has no effect upon its conductivity. Machinability is said to be approximately 80% that of free cutting brass. The alloy is intended for forgings and screw machine parts.

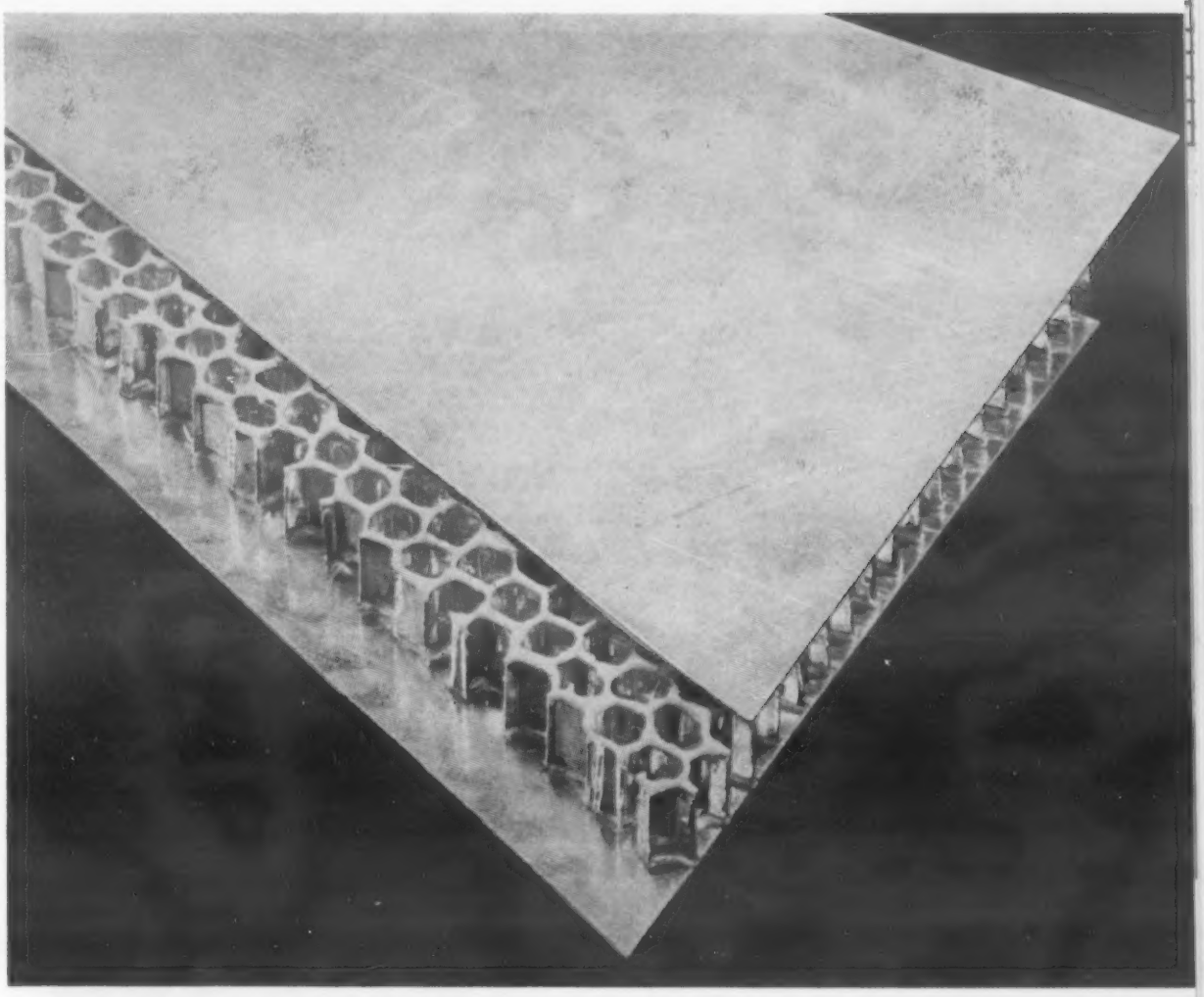
Although not new alloys, changes in processing brass alloys gives them properties and characteristics much superior to most brasses produced by standard methods. Brasses produced by the new method bear the name Formbrite and are said to be stiffer. yet more ductile than comparable grades.

The method of processing results in a grain size of 0.012 mm or less which imparts good polishing and finishing characteristics, high tensile strength, hardness and ductility. In many cases, parts made of Formbrite can be plated after only a simple buffing operation.

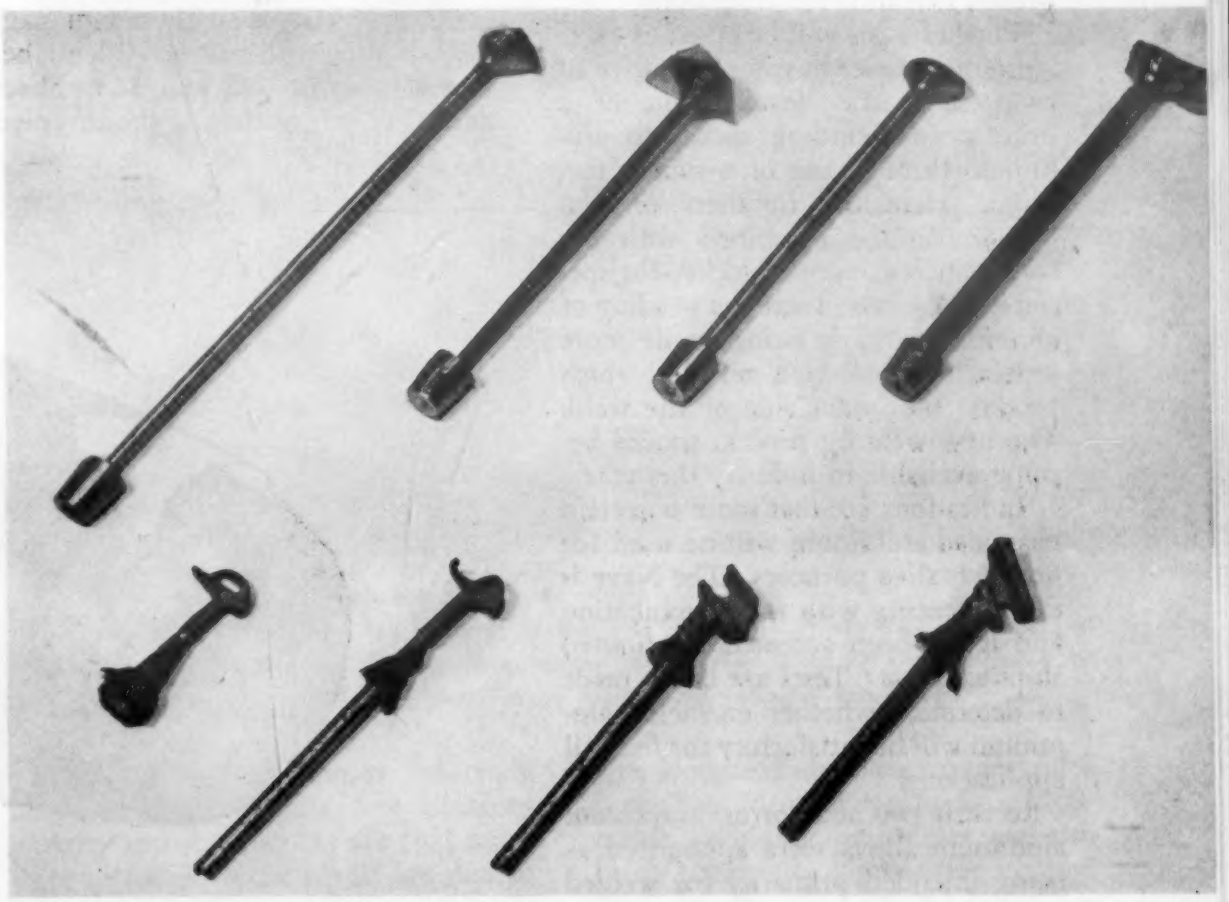
In a 70/30 brass, Formbrite has a tensile strength of 63,000 psi as compared to 54,000 psi for annealed stock and 60,000 psi for standard half-hard 70/30 brass. Highest advantages of Formbrite are said to be in thin stock.

Aluminum Alloys

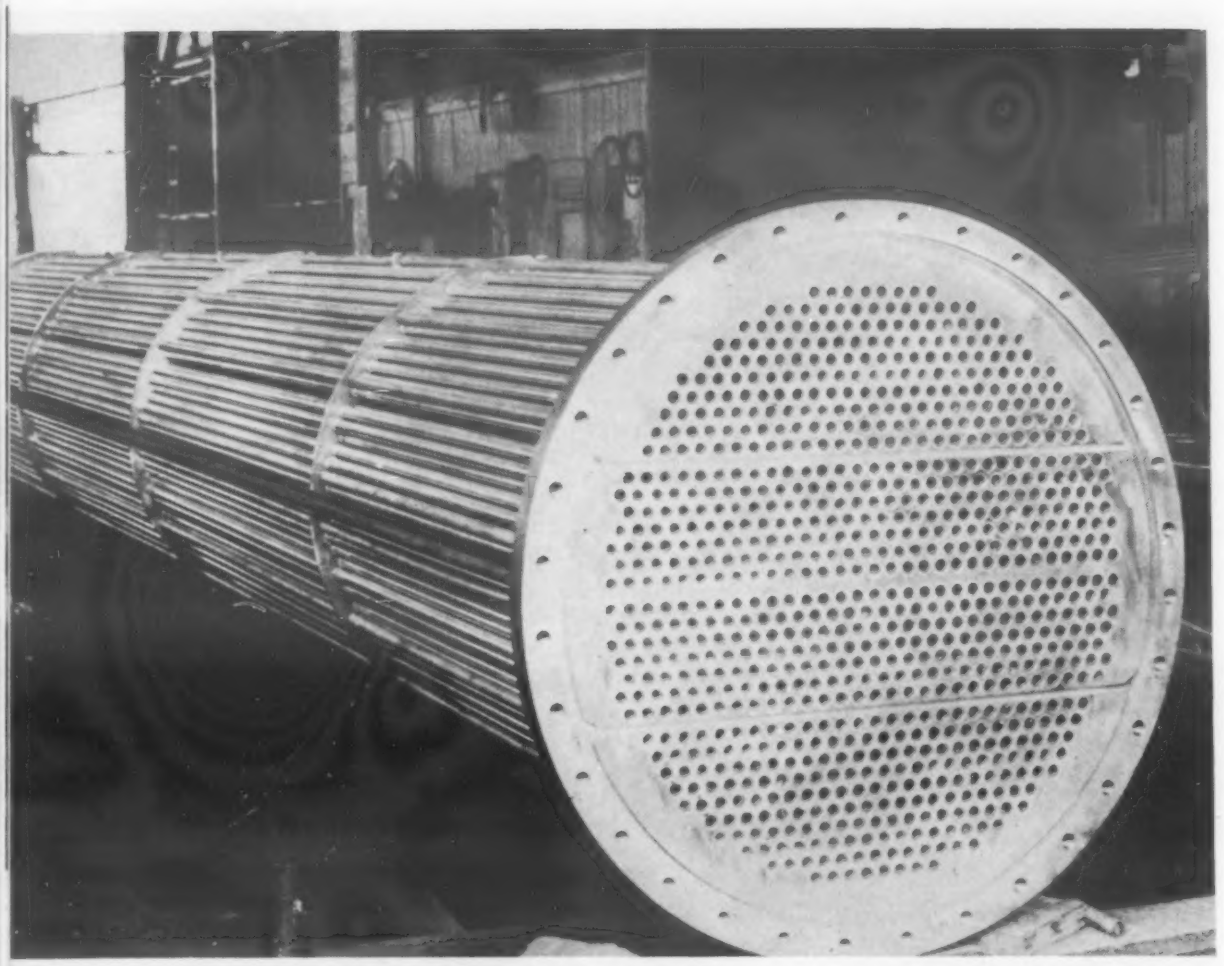
From all indications, the use of aluminum will continue to grow in military and civilian applications. Aluminum capacity has been increased tremendously and current expansion plans are great. From all sources come predictions of increased usage. Aluminum is stepping into many applications formerly handled by mate-



An all-aluminum honeycomb material recently made its appearance. The core is made of corrugated aluminum foil to which is bonded sheet aluminum. Core density is easily varied for specific types of application.



Through a new casting process, titanium and zirconium are being made into various types of parts that have the features and possibilities of investment or permanent mold castings. The process, which recently emerged from the laboratory, should widen the applications of the new materials.



Longitudinal butt welding is used to produce the welded aluminum tubing in this heat exchanger. Cost of welded tubing is considerably less than for drawn and extruded tubing.

rials that are still scarce. In addition, both military and civilian planes are becoming larger with correspondingly greater demands for aluminum.

Further steps will be taken to make aluminum easier to use. Indicative of progress is the development of a process for bonding nickel to aluminum through use of a rubber medium. Here the lightness of aluminum can be combined with the corrosion resistance of nickel for special applications. Inert gas welding of aluminum also is being made more satisfactory through a new flux which protects the under side of the weld. The new welding process should become available to industry this year.

Indications are that more porcelain enameled aluminum will be used for nondecorative purposes. The Navy is experimenting with this combination and it has been accepted for limited shipboard use. Tests are being made to determine whether enameled aluminum will be satisfactory for firewall applications.

Recently two new corrosion resistant aluminum alloys were announced as being intended primarily for welded assemblies such as pressure vessels, tanks and highway transportation equipment. The alloys, XA54S and XC56S, can save approximately ½ the thickness of materials now used for the listed applications. Weight and cost can both be reduced with these alloys.

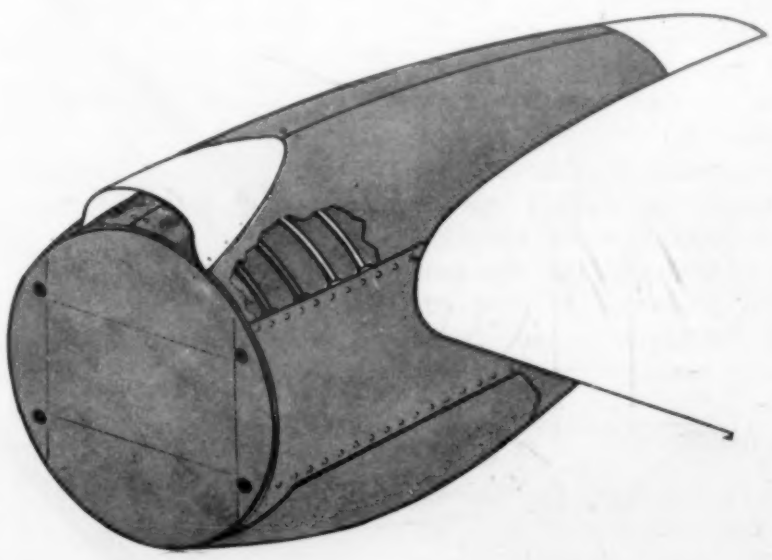
Alloy XA54S is an aluminum magnesium alloy with properties lying between those of 52S and 56S. Sheet and plate is furnished in the annealed and intermediate work hardened tempers. Alloy XC56S is similar to the standard 56S alloy, but has better welding characteristics. It is used in the annealed (–0) and hot rolled (–H112) tempers. Intended for high strength structures, XC56S is about 25% stronger than XA54S in the same tempers.

Both alloys are weldable by the inert gas metal arc process (argon-tungsten) or semi-automatic inert gas metal arc processes. Welds are ductile and have good elongation properties.

If there is a continued shortage of plating materials for automotive trim, another new aluminum alloy could take on this type of application. Alloy C57S will take a brilliant Alumilite finish. The alloy can be finished in colors if desired. It approaches high purity aluminum in appearance, but has better mechanical properties.

A more economical form of high strength aluminum parts is indicated by the perfection of a method of making strong mechanical parts by impact extrusion. Higher extruding pressures are needed than for ordinary impact extrusions.

The usual advantages of impact extruding are available in aluminum alloys 61S, 14S and 75S. Strength of parts is equal to that of forgings, surface smoothness is better, tolerances are closer, and there is little need for the usual forging draft angles. Much machining is eliminated and considerable savings in materials can be



Nacelles for DC-7 airplanes are being made of titanium in one of the first commercial uses of that metal. Several companies are working on titanium production research projects to chart production and design techniques.

realized.

The progress which has been made in producing large aluminum assemblies in one operation should reach a state where practical advantage can be taken of their potentialities. Part of the development is in the so-called large press program, but also of importance are the forging of aircraft wings and the extrusion of stepped wing spars in one piece. All of these developments tend toward the reduction of raw materials costs, scrap losses and elimination of many costly assembly operations. There will be other advantages when the new processes reach a state of perfection. For example, in cast or forged airplane wings, weight will be reduced appreciably and smooth outer surfaces will be achieved. Both have important effects upon the flight properties of planes.

In the large press program it is anticipated that presses with capacities of 50,000 tons and up will soon be in operation. Here again, many fastening and joining operations can be avoided in building up large sections for aircraft. Higher strength at less weight will be the net result.

Magnesium

In the case of magnesium, 1953 will see the start of a steady flow of sheet and plate magnesium as two major rolling mills go into full production. Sheet and plate in increased sizes and quantities will make magnesium available to applications for which the material has been restricted. Magnesium plate in thicknesses of 3/16 in. and up has been reduced in price by about 20% and is now offered at a price per pound equal to that of aluminum.

Progress has been made in casting a complete airplane wing of magnesium, complete with stiffeners and all integral components. It is likely that some commercial production of such wings will be offered by the armed services during the current year. Too, it is likely that we will see an increase of magnesium in other cast forms. Shell moldings are being made experimentally in magnesium, and improvements are being made in magnesium investment castings. A further increase in the use of magnesium die castings is also expected now that automobile manufacturers have started using magnesium in this form. More and more plating is being done on magnesium parts, making possible more decorative or processing applications.

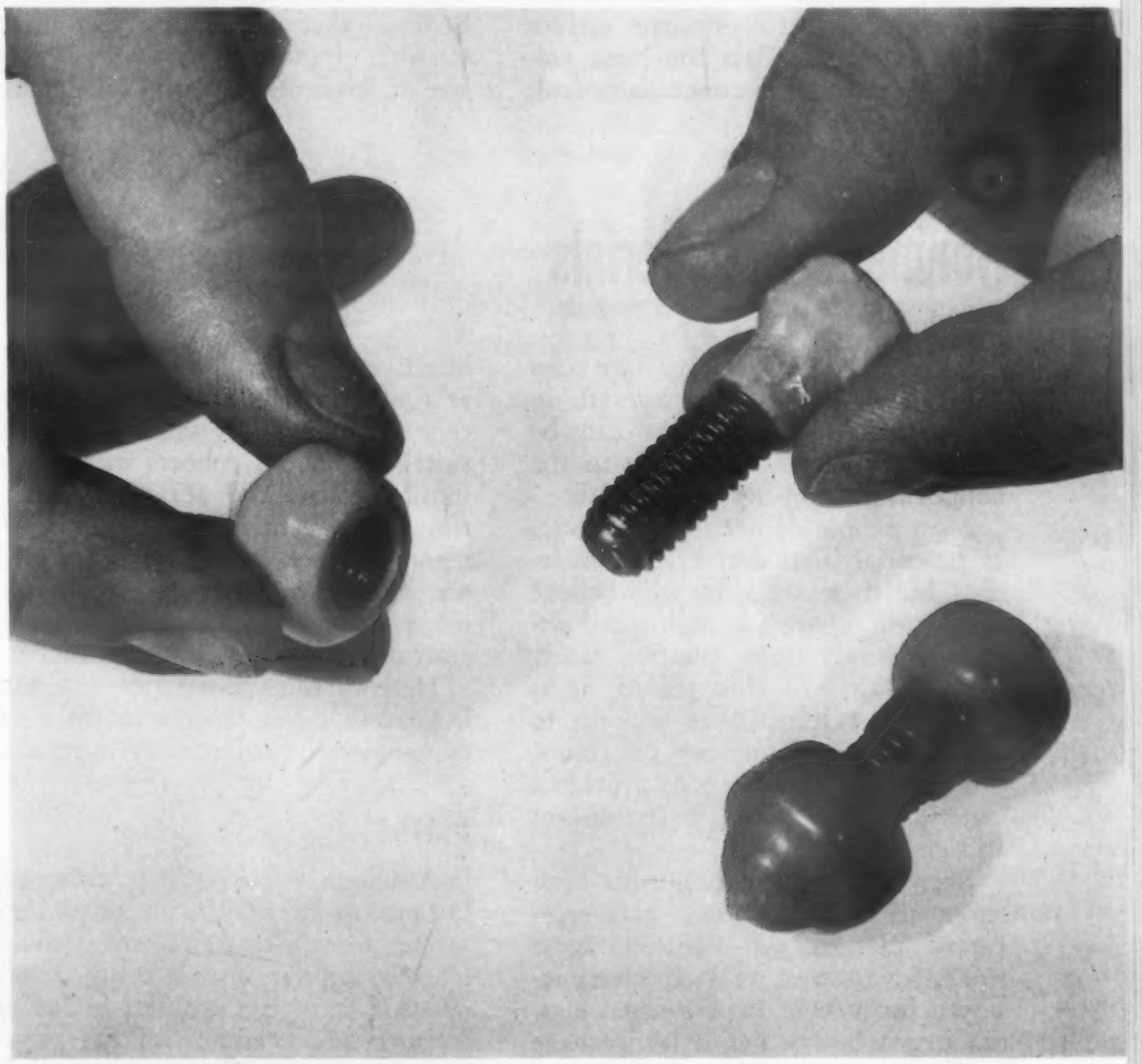
The use of magnesium as an alloying element in several other metals, including titanium, aluminum and ductile iron, continues to take the greatest percentage of that material today, but all current indications are that magnesium will grow in importance in its own right. No new major alloys have been announced recently, but it is known that alloy development is being directed toward better welding alloys and improving the high temperature properties of others.

Titanium

After many years of attention to titanium, potential users are about to make actual applications. Already some aircraft have a few titanium parts, and the chances are that more are to come. More plants are due to produce titanium sponge, and there is a growing list of companies who will roll and forge the alloys into finished forms.

There is somewhat of a chicken and egg situation in titanium today. The price is still high because production is low. On the other hand, some potential users are not contemplating the use of titanium because the price is too high. In an attempt to resolve this dilemma, federal agencies are spreading the word about titanium and its merits in an attempt to get small business to use this promising material.

Meanwhile, research continues as to less expensive ways of reducing the metal from its oxides toward the best alloys and to find the best methods of fabrication. A casting process which has been developed in the laboratory will soon be ready to emerge and offer a cheaper form in which to use the metal. Welding procedures are also being perfected. A promising method involves the use of the inert-gas tungsten-arc process with helium or argon as the most likely gas. So, while titanium cannot yet be classed as a material for mass production, this



Vinyl plastisols and plastigels are finding increasing uses where their use as dip coatings is recognized as valuable. The coatings of the nuts and bolts shown here are achieved by a simple dip process. In this case, coated low carbon steel is made capable of replacing stainless in parts to be used under corrosive conditions.

year and each succeeding year should see a closer approach to that status.

Under a special engineering design contract with the U. S. Air Force, Northrop Aircraft is checking on the use of titanium for making rocket firing wing tip pods for the Scorpion F-89D. Primary purpose of the contract is to determine fabricating techniques and obtain engineering design data on titanium. The pod was selected for the trial because its design and construction involve the greatest variety of forming, machining, welding and other fabricating techniques of any unit of comparable size.

Among the areas where investigations are continuing in making the use of titanium more practical are those processes to improve surface hardnesses. Titanium has been successfully nitrided in ammonia or tank nitrogen. In addition, research goes on to find good plating techniques.

Minor Metals

We shall hear more about several of the minor metals this year. In particular, germanium will demand considerable attention as its properties and potentialities become better understood. It is understood that more than 70 companies are actively looking for, extracting or applying germanium. Currently, the germanium which is used is made into diodes, rectifiers and transistors for radar and other electronic applications.

Perhaps the greatest future for germanium lies in its promise to replace vacuum tubes for many functions. In the form of transistors, it is believed that germanium will make possible dramatic reductions in the size of certain equipment. Likely possibilities are extremely small hearing aids, the long heralded wrist-watch radios, and electronic computers of about one-tenth their present size.

A growth in the use of transistors will have a profund effect on many materials. The nickel and tungsten requirements for vacuum tubes will be cut tremendously. Batteries will have to be redesigned, probably using less materials. Steel and other materials housing electronic equipment will feel the effect of reduced size per unit.

Silicon will also come under more careful study for use in transistors. The element is available in its pure form and is much less expensive than germanium, which now costs about $350 per lb. Even though transistors are as small as the head of a kitchen match, price is important when quantity production is contemplated.

Nonmetallic Materials

Although many advances have been recorded in nonmetallic materials in past years, more progress can be anticipated soon, particularly in the field of high temperature materials.

Most people do not regard plastics as potential high temperature materials, but there are some who believe that future progress in high-speed aircraft depends upon plastics rather than metals. In this regard, it is known that research is seeking to combine the advantages of resins, ceramics and glass fibers to provide a material that is strong, heat resistant and easy to form.

Even without the sought-for high temperature properties, glass-reinforced plastics will continue their steady invasion of fields formerly reserved for metals. Experimental plastics automobile bodies of last year are to give way to limited production runs of a standard make automobile. Recently, reinforced plastics bathtubs were announced as being available, and are said to offer many advantages over the standard type. Plastics of this group have already gained acceptance in the home appliance field and are now going to become more evident in industrial equipment. Plating tanks are now made of the reinforced materials with the promise of longer service life and freedom from metal pick-up in the baths.

Aircraft requirements will have an effect on other nonmetallic materials, as for example, silicone rubbers. Recent developments which have resulted in silicone rubbers with better tensile, elastic and abrasion properties indicate that further improvements are soon to be expected. Based on past improvements, these versatile materials will probably move into aircraft ducting and sealing operations.

Here are some of the more interesting recent developments in the field of nonmetallic engineering materials.

Plastics

Although there is still some reluctance in industry to accept plastics as engineering materials, many more plastics applications are being developed. Part of the progress is due to a better understanding of the properties of plastics. However, more plastics are being made to suit the needs of the day.

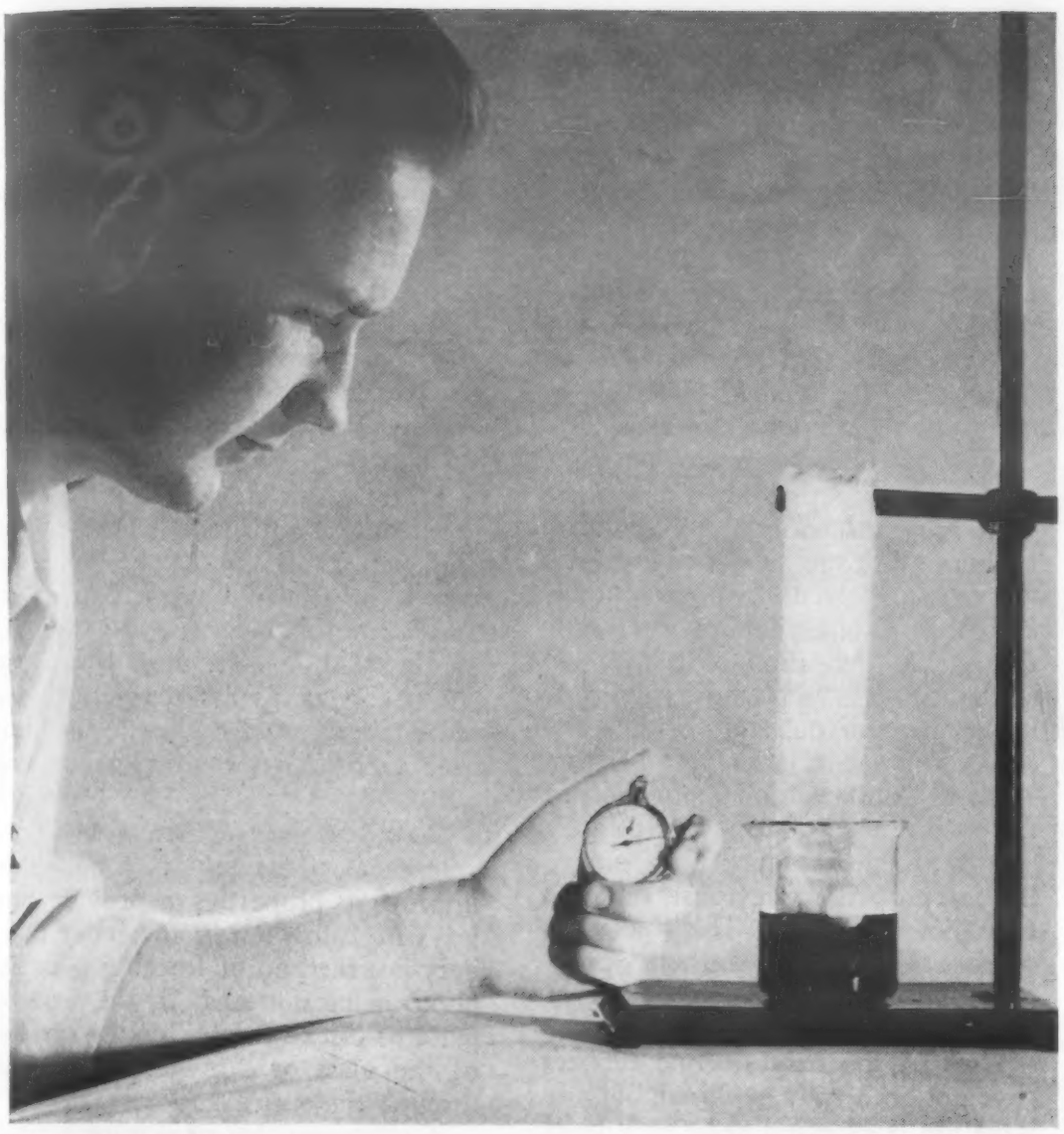
For example, more and more plastics are being developed to withstand higher service temperatures. The plastics referred to would not be classed as suited to what is generally regarded as high temperature service, but they will stand up under temperatures somewhat above the boiling point of water. Plastics now available can serve at temperatures as low as –60 F and as high as +500 F, with various ranges in between.

One new polystyrene is suited for applications where temperatures reach 220 F. The material is expected to find considerable use in the manufacture of electrical equipment. The new material has a top temperature limit that is about 20 F higher than other polystyrenes.

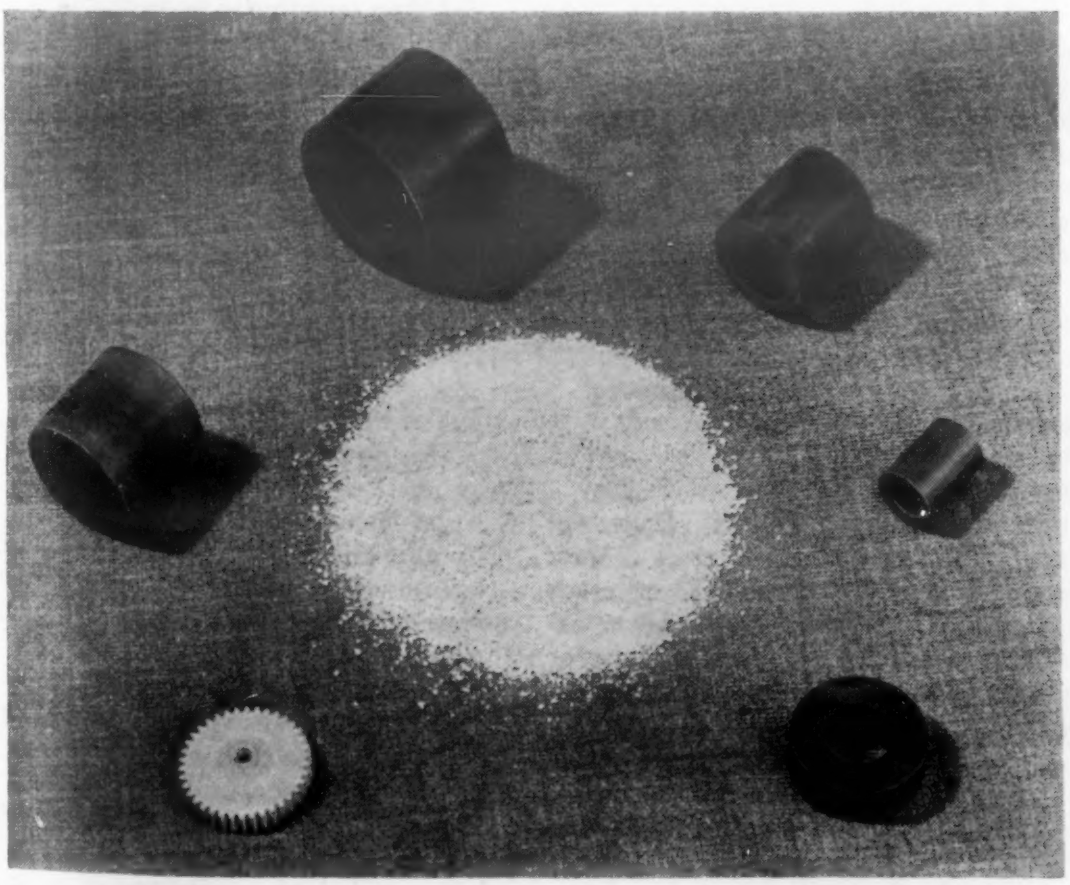
Among the developments of one company are three new polyester resins capable of withstanding prolonged exposure to temperatures up to 500 F. Polyester resins are the type most frequently used in making glass reinforced plastics parts. When reinforced with glass fibers, the resins offer flexural strengths of from 30,000 to 35,000 psi at 500 F. This combination will probably find considerable use in tanks and other processing equipment where hot liquids are employed, as well as for piping of many kinds and in plumbing fixtures and similar products, as well as in aircraft applications.

With the use of high temperature polyester resins, it is entirely possible that nonmetallic airplane fire walls will be used to replace stainless steel and other metals. Even without the new resins, glass-reinforced plastics have proved superior in many respects to metals.

Improvement in the life and strength of reinforced plastics is expected through another development



A new ceramic fiber presents interesting possibilities to industry. Available in blanket rolls, batts, paper and tape, the fiber has an exceptionally low heat transfer rate and resists sustained temperatures up to 2300 F.



Powdered nylon is now being pressed and sintered in making such parts as bearings. Nylon can be used alone or metallic powders can be blended in to provide additional properties. Excellent bearing properties are provided in blended powders.

in which the glass fibers are coated with silicone before being impregnated with plastics. The silicone coating provides a better bond between resin and glass.

Several types of foaming plastics have been made available in recent years. Their acceptance has been slow for various reasons. Lately an aircraft company developed its own compound, a foaming Vinylite plastisol, which is being put to use in aircraft sections to act as a stiffener and strengthener without adding much in weight. Actually, when provision is made for use of the foaming material, important weight savings can be made.

The material expands and cures at low temperatures and low pressure. It is flame resistant and flexible, light in weight, and resists aging, moisture, abrasion, tearing, alkalies, acids and most chemicals. Properties can be varied according to the formulation selected.

Early last year, we were told of a new combination of materials as a result of the discovery of a bonding method for joining the fluorocarbon plastics to metals and rubbers. The resulting laminates provide materials with the heat resistance, chemical resistance and electrical properties of the fluorocarbons with the properties of the second materials. In addition, the reduced quantities of fluorocarbons in thin sections make their use more practicable. Possible uses include chemical tanks, piping, gasketing, electrical applications (including printed circuits), and in aircraft applications for handling high octane gases and aromatics.

An important as well as interesting development extends the advantages of the powder metallurgy process to nylon. Nylon mechanical parts so formed have higher dimensional stability than conventionally molded nylon. Among the parts made by pressing and sintering are bearings which are reported to have exceptional wear resistance and superior frictional properties. In addition, there appears to be less internal strain than in normally molded nylon parts.

In making mechanical parts, powdered nylon is pressed into the desired shape and then sintered at a temperature somewhat below the melting point of the powder. Although nylon can be used alone, it is frequently used with such filler materials as copper, lead and graphite to add special properties.

Early applications for sintered nylon parts are chiefly in the field of

bearings. Uses being investigated include: oil seals, gears, cams, rollers, thrust washers, lapping and abrasive tools, and sliding contacts. Of course, the filler used with nylon powders would vary with the application and would be chosen for the particular property or properties it would add.

Polyester resins are used as the basis of a new potting compound. The compound is used for potting, encapsulating, sealing, embedding and impregnating electronic units. Use of the potting material insulates sensitive mechanisms against shock, heat, vibration, moisture and corrosion. Shrinkage can be controlled so that no damage will be done to delicate components. The compound sets at room temperature in 10 to 15 min., although the time can be shortened. It has good impact strength and thermal shock resistance. The resins used are compatible with many plastics, but not urea and phenol-formaldehyde resins.

A new method of forming gaskets employs resin compounds which are forced through a nozzle onto a spinning component part and then baked to form a solid gasket. Known as flowed-in gaskets, they can be made of specially formulated compositions, either solid or cellular. One of the first uses of the process has been in sealing the glass fronts of instruments.

Rubbers

Two new developments in rubbers help overcome some of the major obstacles in the use of these materials by providing improved properties. One is a so-called synthetic rubber and the other is a silicone rubber.

The major feature of the synthetic rubber is its resistance to the effects of high octane gasolines such as are used in aircraft engines. The rubber is a mineral-filled nitrile, with clay being the chief component. The composition reduces the swelling effect of the gasolines and helps the rubber's electrical properties and resistance to elevated temperatures. Rubbers of this type can be formed by transfer molding and can be bonded to metals by using rubber-phenolic adhesives.

Silicone rubbers can now be made with mechanical properties comparing with those of natural and synthetic rubbers. Silicone rubbers have been barred from some applications because of relatively poor tensile strength and abrasion resistance. By a change in compounding and by using ultra-finely ground silica in the composition, tensile strength of from 1000 to 2000 psi and elongation of from 200 to 800% can be achieved. These properties more than double the best properties previously reported for silicone rubbers. The change in composition produces the better properties without causing any loss of other favorable characteristics.

Uses of the new silicone rubbers have not been fully explored, but one large use is expected to be in V-belts and other driving equipment. The material is now available in experimental quantities, with commercial production anticipated by mid-year.

Other Nonmetallics

One of the most interesting new materials to come along recently is Fiberfax. This ceramic fiber is made by melting aluminum oxide, silica and modifiers and then blasting the molten mixture with a controlled air jet.

Although the new material is too new to have found any substantial uses as yet, its favorable properties make it the subject for intensive study. Fiberfax resists sustained temperatures up to 2300 F and does not soften at 3000 F. It is light in weight, has an exceedingly low heat transfer rate, has good electrical properties and excellent filtering efficiency. It also resists the corrosive effect of most acids.

Fiberfax can be produced as a mat or as blanket rolls, bonded batts, tape and paper. It cannot be spun or woven by itself. Expected fields of application include furnace linings, as electrical insulation in the paper form, and as a filter medium to remove smoke and fumes. Some has been used in jets for thermal insulation.

As old as glass is, there are still developments from time to time which improve its properties or provide new ways of using it. In the latter category is a method of forming glass by photochemical means. By the process, patterns can be formed on the surface of the glass or can be made to go through the entire thickness.

A photosensitive glass is used. The areas to be treated are masked with the desired pattern, exposed to ultraviolet light and then the glass is heated at 1200 F. The exposed areas are then sensitive to hydrofluoric acid, which eats away the modified portion. Although the process is time-consuming, it is highly useful in perforating glass, particularly with extremely fine holes, and in making plates for printed electronic circuits.

Parts and Forms

For years there has been a strong trend toward those processes which make parts requiring a minimum of machining and finishing as secondary operations. As labor costs increase, it is sometimes wiser to spend more money on costly dies and molds, if the extra expenditures can reduce or eliminate secondary operations. Thus, the older methods of producing precision parts continue to draw new adherents. Too, all of the new methods are being examined closely to see if they fit current requirements and have anything to offer. Increasingly important among most of the processes is their common trait of saving materials through better utilization, fewer rejects and less need for machining or grinding to attain required critical dimensions.

Interest in shell molding as a means of producing castings reached an intense point last year, and it is believed that during the current year a better evaluation will be made of the process and its possibilities. A few years ago, shell molding was believed to be restricted to the casting of aluminum alloys and copperbase alloys, but now it is being extended to other materials, notably stainless steel and magnesium.

Because of the foundry costs of shell molding, answers will be sought to reduce these costs through less expensive equipment and cheaper resins. If ways can be found to overcome the cost angle, shell molding will become better suited to small runs of parts. Now, many observers feel, only large quantities of parts can justify shell

Shown here are examples of impact extruded mechanical parts made of high strength aluminum alloys. For many applications, impact extrusions can compete with forgings.

molding and then only when machining and finishing costs can be reduced sufficiently through the better quality of casting attained by shell molding.

Extruding is coming into its own as a method of making parts, both large and small. Progress in impact extruding makes possible the production of parts formerly made as forgings, and interest in this development indicates that many parts will be made by the less expensive process. So far alloys 61S, 14S and 75S have been made into mechanical parts by impact extruding. Strength of such parts is equal to forged parts of the same alloys. In addition, surface smoothness is better, tolerances can be held more closely and there is usually no need for the draft angles usually associated with forgings.

Most experimentation has been completed on the hot extrusion of steel and high alloys, and within the year, three or four plants should be making shaped extrusions at least for their own use, and possibly there will be some capacity remaining for industry in general. Most hot extrusion of steel and high alloys will be made by a French process, which was first described in MATERIALS & METHODS several years ago.

As reported in the section of this report devoted to nonmetallic materials, the next year should see tangible results of experimental programs to press and cast aluminum and magnesium into huge wing sections for aircraft. Materials will be saved, stronger structures will result, and immense savings in joining can be expected when these processes are used in production.

Recently we heard of the possibility of making large parts by metal spraying. Such parts would be made of high melting point materials that cannot be cast, press formed or forged either because of the shape involved or due to formability of the metal desired.

Among the specific new developments in parts and forms during the last year are:

One of the most interesting new processes is referred to variously as mid-air forging, impacting and impact forging. The latter name is most descriptive of the method which was first used to make knife handles and is now being accepted widely as a means of making jet engine blades. Much is expected of the method in the postwar period for making many small, quality parts.

In the process, two air-operated impellers move toward each other, each bearing half of a die. The dies meet and close over the blank and form it. Precise automatic control over all steps of the forming operation are essential to make certain that the metal is heated to the proper temperature, that the blank is fed to the dies at the proper time and in the exact location, and to see that the dies move forward at equal rates and meet at the precise moment.

Advantages of the process is that stock is worked equally from both sides; there is a minimum of die contact which should add to die life; stock is moved faster; and less total energy is required.

A new metal forming process gives promise of making practicable the deep drawing of lesser quantities of parts than were once required to consider drawing. Known as Hydroforming, the method requires only the use of a male die or punch. The punch is pushed into a flexible, hydraulically pressurized die number. Two sizes of presses are available, with 12- and 26-in. capacities. An advantage of the process is that metal being formed receives pressure uniformly throughout the blank. Thick or thin metals, easy to form or difficult, can be deep drawn in one step without marking the metal. Much of the cost saving in the process is due to its need for only a relatively simple die, and where deep draws are required, progressive dies are often unnecessary.

With the increased interest in titanium and zirconium, it is im-

portant to note that progress is reported in developing a method for casting these metals. Both metals have been available in wrought forms only up until the present. The metals are highly reactive to gases and, therefore, are difficult to handle in the molten state.

In the casting process reported, parts from a few ounces up to several pounds have been cast with a fairly high degree of accuracy. In casting titanium, the metal is melted by an electric arc in an inert atmosphere (argon) furnace. Casting can be done either under pressure or in a vacuum. After setting in the molds for about 5 min., the parts can be removed. Molds are made of high thermal conductivity materials. It is probable that most castings of titanium or zirconium will be made as permanent mold or investment castings.

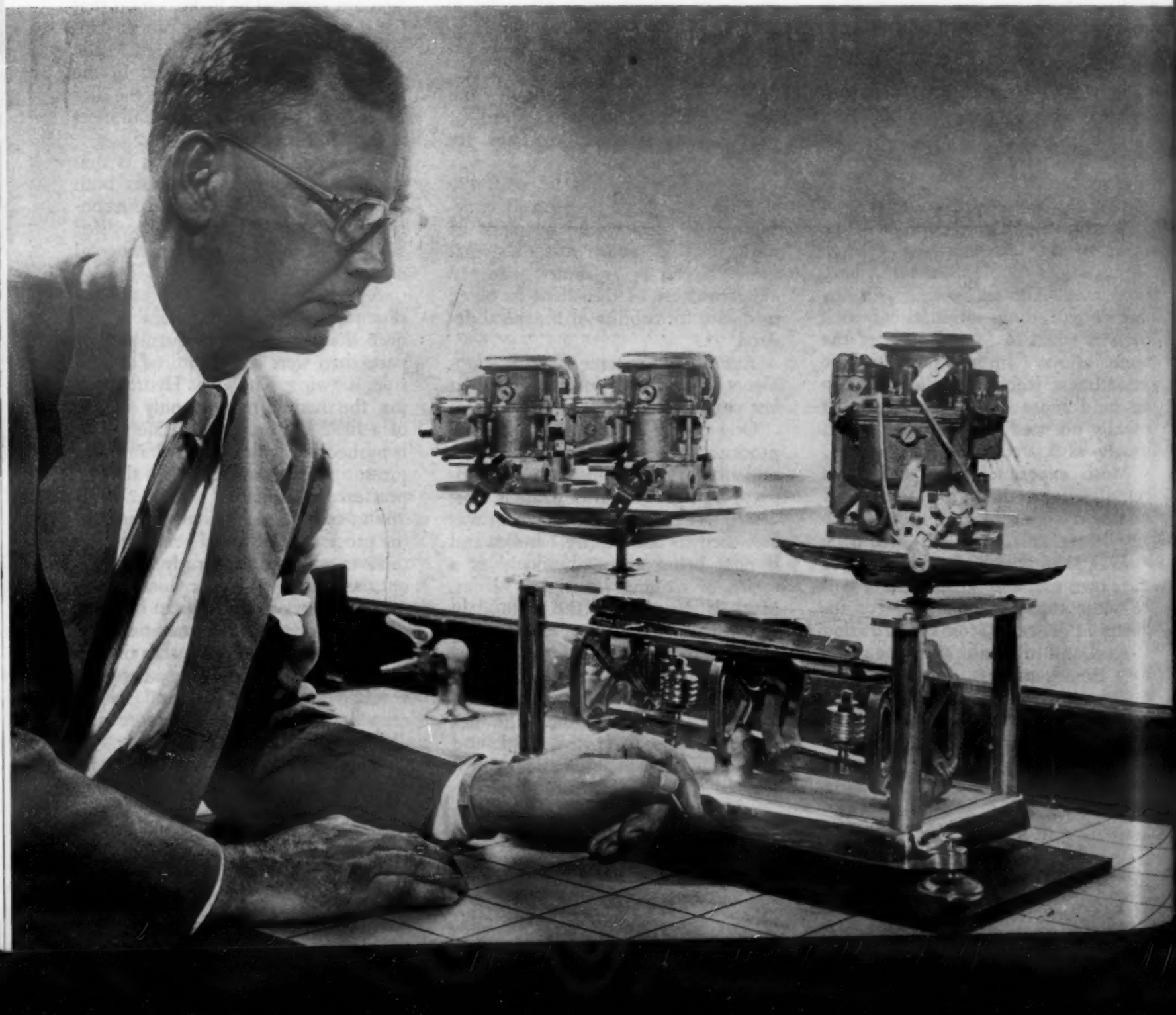
The making of jet engine turbine blades and buckets has plagued industry for more than 10 years, and every so often another method is developed which promises to make easier the manufacture of such parts from hard to work materials. Two grinding methods are now being given production trials to see how they fit into the picture. In one method, roughly formed blades are finish ground by the use of abrasive coated belts. Cams control the contours ground and are said to be capable of grinding to an accuracy of 0.003 in. Masters are used to guide the cams, and a 4½-min. cycle is needed to finish the parts. The other process is reported to be capable of grinding the shape from a solid by complicated control over all motions of the grinding wheel and blank.

The inherent speed and economy of impact extruding is now being used to advantage in making strong parts from aluminum alloys 61S, 14S and 75S. The process saves materials and eliminates machining in making parts which compete with forgings in strength. Higher extruding pressures are needed than for ordinary impact extrusions.

Tolerances being obtained now include: width, ±0.010 in., wall thickness (forward extrusions) ±0.005 in., wall thickness (reverse extrusions with a punch slenderness ratio of 3:1 or more) ±0.015 in., others ±0.005 in. In lengths extruded to final length, dimensions can be held to ±0.12 in. and bottom thicknesses to ±0.010 in.

Powder metallurgy methods have recently been used successfully in making parts from nylon powders. Powder, either pure or mixed with lead, copper or graphite, is cold pressed to shape and then sintered at temperatures slightly below the melting point of nylon. Thus far the process has been used chiefly for making nylon bearings, which reportedly have exceptional wear resistance and frictional properties. Pressed and sintered nylon parts are said to have greater dimensional stability and less internal strain than conventionally molded nylon parts.

Indicative of the increased competition between materials are these carburetors in the new De Soto. Aluminum is used in the new type pair at left, and zinc in the old one at right. In the new design either material can and will be used, depending upon the price and supply situation.



Finishes and Coatings

Always one of the most active fields of materials engineering, the search for better coatings and finishes for metals keeps on at a steady pace. For today's use, finishes must be harder, easier to apply and capable of withstanding greater heat and more corrosive conditions. As the light metals come into greater importance, there is a mounting pressure for better and easier plated coatings for magnesium, aluminum and titanium. To be sure, there are now methods of plating aluminum and magnesium, but the need for easier and surer plating methods is still great. Aluminum and magnesium are being used to a greater extent in die castings for automobiles. Even more of these materials would be used if it was easier to give them decorative metal coatings which would match the plates of the external steel parts on the automobiles.

It seems that nickel will still be restricted as a plating material for decorative plating applications. Therefore, it is logical to assume that variations in plating processes will come along to make the best of the shortage of nickel. The white-brass method of which we have heard for the past two years now seems to be taking its place as the successor to copper-nickel-chromium plating.

In nonmetallic coatings, there is a trend toward the use of the newer resin based finishes, such as the recently publicized epoxide coatings. Coatings made from these resins are unaffected by many reagents. Among the products upon which epoxide coatings are now being used are home appliances to resist abrasion and to withstand the destructive effects of soaps and detergents. New epoxide coatings have good adhesion and can be baked on air dried.

Among the other recent new finishes are these:

Chemical and electrochemical methods of finishing metals, particularly aluminum. New chromate coatings have been developed that are capable of replacing anodized coatings on aluminum. Chromate coatings are neither oxide nor phosphate coatings, but are chromium-chromate in nature. They become part of the metal itself rather than a film, and do not have any effect upon metal thickness. Newer chromate finishes resist abrasion exceptionally well. Color and corrosion resistance of the coating vary with its thickness.

All aluminum alloys and forms can be coated by the chromate method, and application times can be as low as 30 sec. By preventing the formation of the normal oxide coatings on aluminum, the chromate coatings are an aid in welding that metal. There are

Chemical resistance is one of the major reasons why epoxide coatings are coming into prominence. Hot caustic failed to affect the epoxide coating material in the center, but ate away the untreated sample (left) and undercoated sample (right).

Irregularly shaped steel parts can be coated with aluminum in a new process developed by GM Research Laboratories. The coating is used to resist corrosion and, in some cases, to resist heat.

cases where the aluminum is coated and then stored briefly and welded later on without special treatment.

Procedures have been developed to provide thicker anodized coatings for aluminum. By the new method, coatings with denser structures than previously attained, and in thicknesses of from 0.001 to 0.005 in., are built-up. The net result is vastly superior abrasion resistance than the thin coatings. The process is best suited to aluminum alloys 2S, 3S, 52S, 61S and 75S.

A new aluminum alloy has been developed to take a brilliant Alumilite coating that makes possible the use of aluminum as a replacement for chromium plating and stainless steel as automotive trim. The new alloy, called C57S, looks like high purity aluminum, but has better mechanical properties. If desired, the Alumilite coatings can be in various colors.

While coatings for aluminum have received considerable attention, finishes for steel have not been neglected. Of two of the more recent improved coatings, one is primarily for appearance as well as corrosion resistance. The other is chiefly for corrosion resistance.

The use of aluminum as a protective coating for steel is increasing rapidly. Although not a serious competitor of galvanizing, aluminum coating is now an important finishing method for many steels. The older dip-coatings have usually been applied in the steel mill and upon occasion interfered with subsequent fabricating processes. Now, by means of a new dip coating procedure, the aluminum is deposited after fabrication and sound coatings can be deposited, even on complicated shapes. Careful control over the tank lining, racks and the salt composition are most important in the process.

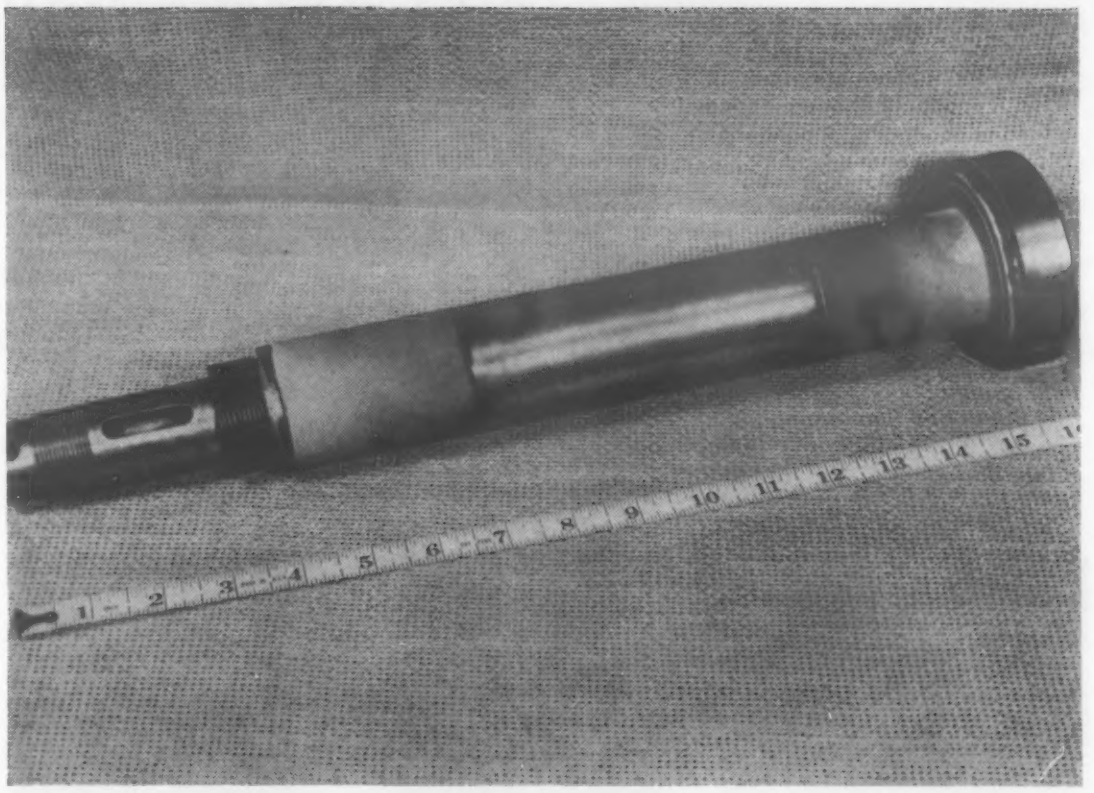
Jet black coatings for steels seem to come to the fore in periods of war production when shiny surfaces must be concealed. Now comes a new blackening process which is said to be much superior in corrosion resistance to earlier coatings of this type. An added feature is the ease of use. The blackening is applied in water solutions at low temperatures. After drying, surfaces are oiled or waxed for better appearance and corrosion resistance.

Tungsten carbide is now being used as a coating material for metals to add to their hardness and wear resistance. The carbide coatings are thin and ductile and are applied by a process now known as flame plating. It is the only known way of de-

positing undiluted tungsten carbide and can also be used with other high melting point materials. Powdered tungsten carbide is used to deposit coatings which can vary from 0.0005 to 0.020 in. The base metal is not heated to over 400 F in the process. Bonding between coating and base metal is best when the coating is used on the softer metals.

Applications for the hard, ductile and wear resistant coating include plug gages, burnishing broaches and core rods for powder metallurgy pressing. Another possibility is to increase die life of dies used with abrasive materials.

Tungsten carbide is also deposited as a hard facing material by another method. In this automatic process, which uses the inert-gas-shielded arc method, powdered tungsten carbide is deposited in a pool of molten base metal by means of a hopper behind the arc. The process is fast and provides the quality of the oxyacetylene deposition methods.



In a process known as flame plating, tungsten carbide is flame sprayed on metal parts to provide added wear resistance. On this spindle, bearing surfaces have been so treated. After spraying, the areas are ground down to final size. Other high melting point materials can be similarly used as coatings.

Processing Methods

It is seldom that spectacular changes take place in the fields of finishing, welding and joining, and heat treating. The same is true this year. It is equally true that developments in these fields cannot be predicted with any degree of accuracy. However, over a longer span of time, we can observe that many improvements have been introduced rather quietly that soon have had a profound influence on major segments of industry.

For example, in heat treating, salt bath heating and automatic flame heating were rather slow to catch hold; but now they are exceedingly important processes in treating metals. In other processing fields, as well as in heat treating, control is becoming more and more important to assure proper results and uniform results from piece to piece.

Too, more and more processes are being converted to automatic operation and are being speeded up in many instances to raise output and reduce handling between operations. In other cases, operations are being combined. Examples of the latter are annealing and restoring carbon in one furnace operation, or brazing and heat treating in one salt bath operation,

Progress in welding has been directed toward easier and more sound welds in aluminum, stainless steels, magnesium and the newer metals such as titanium and zirconium.

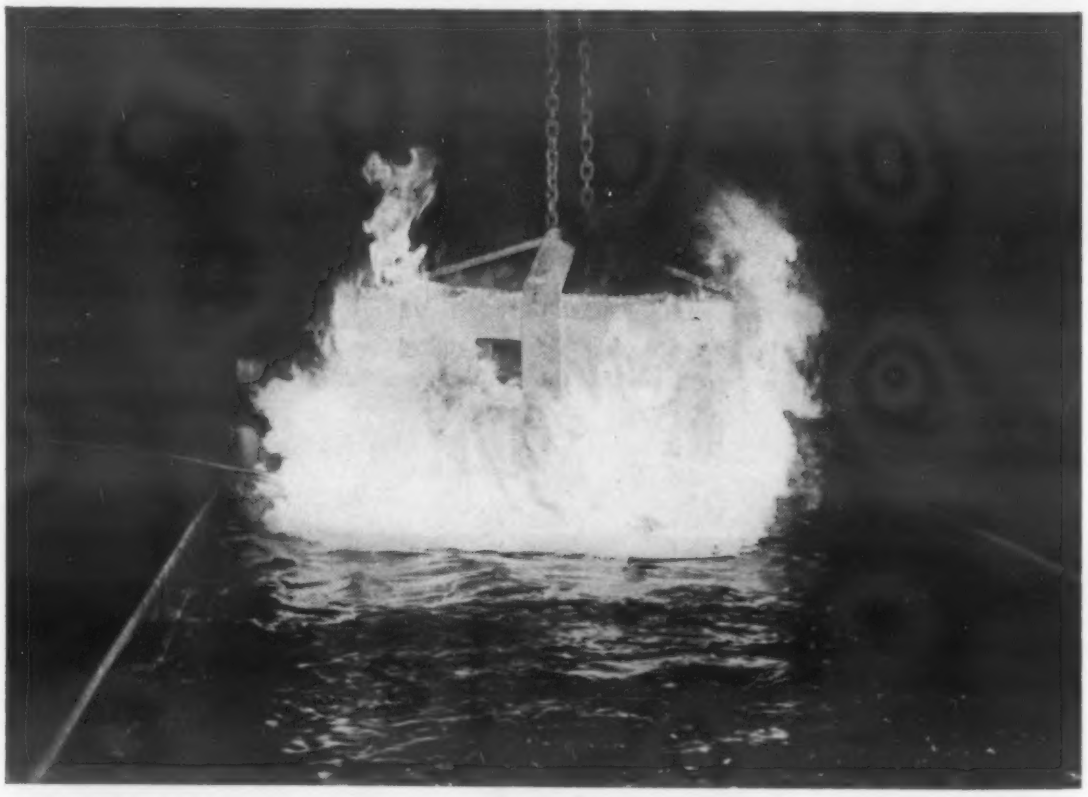
particularly in treating aluminum. Among the newer trends in materials processing are:

Heat Treating

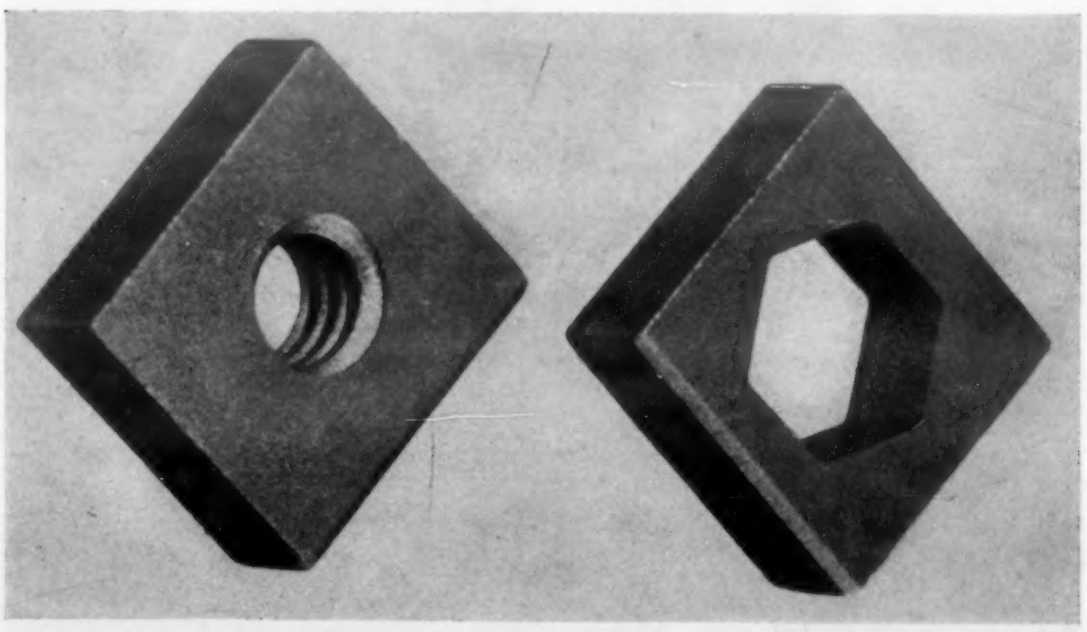
There is considerable competition building up between automatic flame hardening and induction heating for jobs requiring localized hardening in which required quantities are high. Both have advantages for certain kinds of work, with induction-hardening best for regular cylindrical or round shapes and flame hardening machines for irregular areas, where close control over depth of hardness must be extremely close. It is likely that both types of machines will continue to find an increasing number of applications.

In an unusual use of gas heating, shells made of SAE 1010 steel are annealed between cold forming operations by fast heating with gas, rather than by the former salt bath heating. The new method requires only 2 min, as compared to 1 hr formerly required. A rotary gas furnace is used to anneal the mouth end of each shell prior to tapering. The shells are actually under heat for 1 min, 47 sec. Heat varies from 1750 F at the mouth end down to 1150 F, 4½ in. away. Parts are then air cooled.

An interesting new furnace is used now in steel mill production, but its features could be applied in shops working on parts treatment. The furnace is a continuous annealing set-up which, at the same time, restores carbon to the steel being treated. In its present use the furnace handles bars up to 6 in. and wire coils up to 54 in. An interesting system of controls supervises time, heat and atmospheres in six zones of the furnaces. Indicators in each zone show conditions in that area and permit the making of any changes that might be required.



Improvements in heating and quenching techniques for hardening steels are making possible the use of less highly alloyed materials, saving on strategic elements and reducing costs.



As uses for the newer hard materials become more general, ways must be found to cut them. Recently several spark cutting methods have come into prominence which are well suited to shaping carbides and refractory metals.

Joining

There is steady improvement in the processing for the joining of metals. Even though there are many developments en route which strive to reduce the welding and joining required to produce certain assemblies, the amount of welding being done continues to increase. Of course, much of the present research is devoted to problems in joining titanium along with improving the welding of aluminum and magnesium.

For years, carbon steels have resisted the newer welding methods, but an adoption of sigma welding (inert-gas shielded metal arc) using a new argon-oxygen process is now being used. A combination of 5 oxygen, 95% argon is the shielding medium. The carbon steels can be welded at higher speeds and lower currents. Killed and semi-killed steels are most suited to the process because of the porosity in ruined steels. Under special conditions thin steels under 1/16 in. can be welded, but 3/16 to ¾ in. are the most satisfactory thicknesses. When low carbon steels are being welded, a rod of the same carbon content is employed. For higher carbon steels, the rods require a surplus of carbon.

In the section of this review devoted to coatings and finishes, reference is made to a new method of hard facing metal with tungsten carbide. The method using inert-gas-shielded arc methods, deposits powdered tungsten carbide in a pool of molten base metal from a hopper behind the arc.

Galvanic Corrosion

Galvanic corrosion is a faster-than-normal corrosion of a metal which takes place when these two conditions exist: (1) two metals having differing electrochemical potentials are in electrical contact; (2) both are submerged in an electrolyte. Under these conditions the less noble metal corrodes more rapidly than it would if placed in the solution by itself, while the more noble metal corrodes more slowly. Generally speaking, the greater the difference in nobility of the two metals—the stronger the tendency for galvanic corrosion.

The Galvanic Series—It is possible to tell the tendencies of metals and alloys to form galvanic cells by consulting the Galvanic Series chart. The materials grouped together have no strong tendency to produce galvanic corrosion on each other. But putting together materials from different groups can result in galvanic corrosion of the metal higher on the list. The farther apart the metals are on the list, the greater the tendency toward galvanic corrosion.

Anode and Cathode Areas—The areas of two materials forming a galvanic couple have a lot to do with the amount of corrosion which results. In many cases the rate of galvanic corrosion is determined by the ratio of the cathodic metal's area to the area of the anodic metal. For example: if a piece of steel having 2 sq in. of surface is coupled to a piece of copper with a 100 sq in. of area, the galvanic corrosion rate of the steel would be about 50 times faster than if the two metals had the same area.

For this reason it is necessary to avoid galvanic couples where the exposed area of the more noble metal (cathodic) is greater than the less noble (anodic). For instance, it would be dangerous to use steel rivets in copper plates, but safe to use copper rivets in steel plates.

Preventing Galvanic Corrosion—When galvanic corrosion is responsible for a metal failure, poor choice of materials is often responsible. Where galvanic corrosion is possible, combinations of metals as close together as practical on the chart should be selected . . . and combinations where the less noble metal has a relatively small area (compared to that of the more noble metal with which it is coupled) should be avoided. Efforts should be made to increase the resistance of the galvanic circuit by insulation.

Galvanic Series in Sea Water

Corroded End (Anodic, or Less Noble)

Magnesium
Magnesium Alloys

Zinc
Galvanized Steel or
Galvanized Wrought Iron

Aluminum
(52SH, 4S, 3S, 2S, 61ST, 53ST in This Order)
Alclad

Cadmium

Aluminum
(A17ST, 17ST, 24ST in This Order)

Mild Steel
Wrought Iron
Cast Iron

Ni-Resist
13% Chromium Stainless Steel Type 410 (Active)
17% Chromium Stainless Steel Type 430 (Active)

50-50 Lead Tin Solder
18-8 Stainless Steel Type 304 (Active)
18-12-3 Stainless Steel Type 316 (Active)

Lead
Tin

Muntz Metal
Manganese Bronze
Naval Brass

Nickel (Active)
Inconel (Active)

Yellow Brass
Admiralty Brass
Aluminum Bronze
Red Brass
Copper
Silicon Bronze
Ambrac
90-10 Copper Nickel
70-30 Copper Nickel
Comp. G-Bronze
Comp. M-Bronze

Nickel (Passive)
Inconel (Passive)
Type 410 Stainless Steel (Passive)
Type 430 Stainless Steel (Passive)

18-8 Stainless Steel Type 304 (Passive)
Titanium
Hastelloy C
Monel
18-12-3 Stainless Steel Type 316 (Passive)
Graphite

Protected End (Cathodic, or Most Noble)

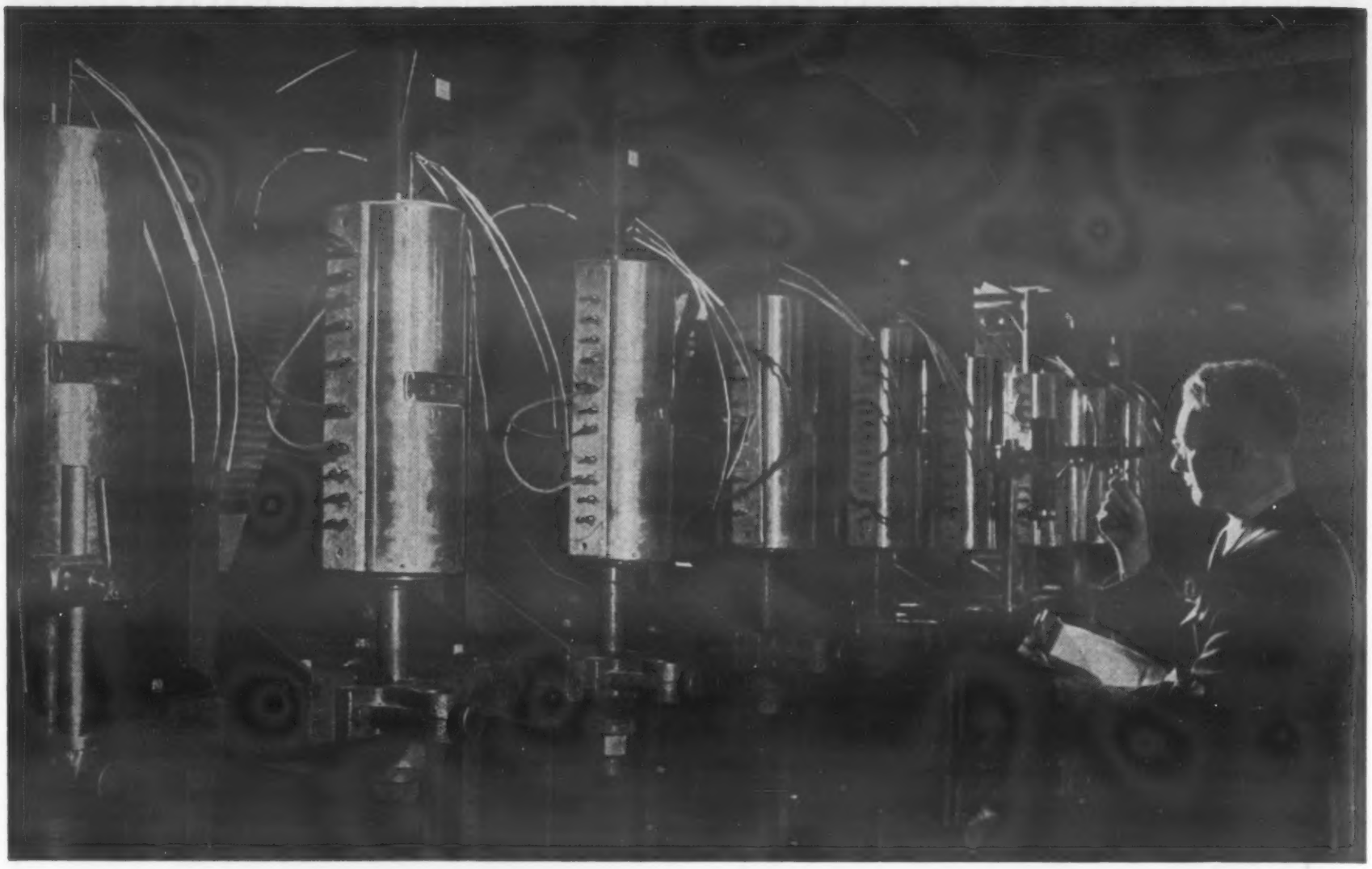
Courtesy of The International Nickel Co., Inc.

Designations and Applications of Chemical and Electrochemical Treatments for Magnesium Alloys

Name of Treatment	Designation				Method of Application	Uses
	Dow	U. S. Navy Bu. Aero	Air Force	AMS		
Solvent Cleaning	—	—	—	—	Rinsing, vapor degreasing, or emulsion type cleaning	Removal of large amounts of oily matter prior to alkaline cleaning. Precleaning step prior to painting.
Alkaline Cleaning	—	MIL-M-3171	MIL-M-3171	—	Hot solution as a soak cleaner or as electrolytic cleaner	Degreasing prior to chemical treatment. Also to remove old chemical finishes.
Chromic Acid Pickle	—	MIL-M-3171	MIL-M-3171	—	Immersion in chromic acid solution	Removal of oxide, old chemical finish, and graphite forming lubricants.
Sulfuric Acid Pickle	—	—	—	—	Immersion	Removal of oxide and surface contamination from rough parts with some dimensional loss; also for pickling after sand or shot blasting.
Nitri-Sulfuric	—	MIL-M-3171	MIL-M-3171	—	Immersion	Same as sulfuric acid pickle.
Bright Pickle	15	—	—	—	Immersion	To give attractive bright finish for "shelf life".
Acetic Acid Pickle	—	—	—	—	Immersion	To provide attractive "matte" finish for M-1 alloy.
Chrome Pickle	1	MIL-M-3171 Type I	MIL-M-3171 Type I	2475	Chemical Dip Immersion	Applied to fabricated magnesium for protection during shipment and storage. Used where low electrical resistance is needed for bonding. Satisfactory paint base.
Dichromate Pickle (Acid)	7	MIL-M-3171 Type III	MIL-M-3171 Type III	2475	Chemical Dip Immersion	Maximum protection and paint adhesion with practically no effect on dimension of parts. Satisfactory paint base for all types of exposure approved by Army and Navy.
Dichromate Pickle (Alkaline)	8	MIL-M-3171 Type III	MIL-M-3171 Type III	2475	Chemical Dip Immersion	Same as dichromate pickle (acid).
Galvanic Anodize	9	MIL-M-3171 Type IV	MIL-M-3171 Type IV	—	Electrochemical	Recommended for M-I alloy interchangeable with chrome pickle on other alloys. Satisfactory paint base for all types of exposure.
Sealed Chrome Pickle	10	MIL-M-3171 Type II	MIL-M-3171 Type II	—	Chemical Dip Immersion	Alternate for dichromate pickle if dimensional loss can be tolerated. Can also be used on M-I alloy. Satisfactory paint base all exposures.
Caustic Anodize	12	—	—	—	Electrochemical	Protective and decorative finish. Available variety of colors not suitable as paint base.
Manodyze	—	—	—	—	Electrochemical	Protective and decorative finish. Satisfactory paint base.
H.A.E.	—	—	—	—	Electrochemical	To provide resistance to salt water corrosion and high temperature resistance. Excellent paint base for all types of exposure.
Plating	—	—	—	—	Chemical Dip (Zinc) and Electroplating	Decorative finish. Good resistance to atmospheric corrosion.

NOTE: Manodyze was developed by Consolidated-Vultee Aircraft Corp.; H.A.E. by Pitman Dunn Laboratory at Frankford Arsenal; and most of the other treatments listed, by Dow Chemical Co.

Courtesy of "The Magazine of Magnesium"



Where Metals Give Up Their Secrets

Suppose you want a metal to combat some particularly destructive set of service conditions.

Here's a man who can help you.

He's one of INCO's staff of engineering specialists and metallurgists. His primary responsibility is to determine how well a material qualifies for its intended use.

Often, he can find an answer to your problem among the metals and alloys he works with daily. He can tell you which of the INCO Nickel Alloys offers the most promising answer to your problem—and he can tell you just as frankly when a problem is outside the known scope of what the INCO Nickel Alloys can do.

Suppose, for example, you were caught in a predicament where you had to find a corrosion-resisting material with greater strength and hardness than you can get even in Monel®. He can name you an age-hardenable alloy that has the same excellent resistance as Monel *plus* mechanical properties you would expect to get only in a heat-treated alloy steel. Non-magnetic, too, down to −150° F. below zero. It is "K"® Monel, one of the INCO Nickel Alloys.

Maybe high temperatures complicate your problem. In that case he would study the service conditions and weigh out all the possible answers to your problem. Inconel "X"® is just one of a number of heat-resisting INCO Nickel Alloys that include Inconel®, the Nimonics, and the new Incoloy® — each one with different characteristics that make it best suited for different types of high temperature problems.

Remember this man. He can tell you where nickel alloys may safely be used to replace others containing even more critical metals. He can save you a lot of trial-and-error experimentation.

If you are wrestling with any problem that involves metals, let him lend a hand. There's no charge, no obligation. If one of the INCO Nickel Alloys cannot solve your problem, he may be able to recommend another metal that will. A note to "Technical Service" at this address will receive prompt attention:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL "S"® MONEL • NICKEL
LOW CARBON NICKEL • DURANICKEL® • INCONEL® • INCONEL "X"® • INCOLOY® • NIMONICS®

Materials Data Sheet

Low Expansion Nickel Alloys

Alloys which have become most widely used are 36% nickel (Invar) for low expansivity up to about 400 F, 42% nickel for temperatures up to 650 F, and 47 to 50% nickel for temperatures up to 1000 F.

COMPOSITION, %	Ni 36 Fe-Rem.	Ni 42 Fe-Rem.	Ni 47-50 Fe-Rem.
PHYSICAL PROPERTIES			
Density, Lb/Cu In.	0.292	0.292	0.296
Melting Point, F	2600	2606	2600
Thermal Cond, Btu/Hr/Sq Ft/Ft/F, 68-212 F	6.05	6.21	6.91
Coeff of Exp per F:			
−200 F to 0 F	1.10×10^{-6}	3.42×10^{-6}	5.37×10^{-6}
0 F to 200 F	0.70×10^{-6}	3.18×10^{-6}	5.55×10^{-6}
200 F to 400 F	1.50×10^{-6}	2.97×10^{-6}	5.55×10^{-6}
400 F to 600 F	6.35×10^{-6}	3.15×10^{-6}	5.55×10^{-6}
600 F to 800 F	8.61×10^{-6}	5.50×10^{-6}	5.60×10^{-6}
800 F to 1000 F	9.48×10^{-6}	8.55×10^{-6}	7.26×10^{-6}
Spec Ht, Btu/Lb/F: 77-212 F	0.123	0.121	0.120
Elect Res, Microhm-Cm @ 68 F	81	70	48
MECHANICAL PROPERTIES			
Mod of Elast in Tension, Psi	21×10^6	22×10^6	24×10^6
Tensile Str, 1000 Psi:			
Annealed	70	76	82
Cold Worked	90	120	140
Yield Point, 1000 Psi:			
Annealed	24	28	31
Cold Worked	70	—	—
Elong in 2 In., %:			
Annealed	36	38	41
Cold Worked	20	—	—
Reduction of Area, %:			
Annealed	68	70	72
Cold Worked	60	—	—
Hardness:			
Annealed (Bhn)	143	156	170
Cold Worked (Rockwell)	—	B100	B103
Mod of Rigidity, Psi	8.1×10^6	8.5×10^6	9.3×10^6
Poisson's Ratio	0.290	0.290	0.290
THERMAL TREATMENT			
Annealing Temp, F	Soften progressively in range 1000 to 2300 F		
FABRICATING PROPERTIES			
Hot Working Temp Range, F	to 2300 F	to 2300 F	to 2300 F
Machinability Index	Machine best at a hardness of about Rockwell C 20.		
Weldability	Can be welded by acetylene torch, metal arc, carbon arc, resistance methods.		
CORROSION RESISTANCE	Resistant to atmospheric corrosion and to fresh and salt water.		
AVAILABLE FORMS	Bars, plate, sheet, strip, wire, tubing, forgings, castings.		
USES	Length standards, instruments, hypodermic syringes, textile machining parts thermostatic bimetal (to 400 F).	Higher temperature thermostatic bi-metal, instruments, glass sealing (temp to 650 F).	Higher temperature low expansion applications (temp to 1000 F).

Courtesy of The International Nickel Co., Inc.

Check the advantages of CENTRIFUGAL CASTINGS IN THERMALLOY*

Now you can obtain cylindrical shapes, such as those illustrated here, centrifugally cast in high heat-resistant THERMALLOY. The advantages of centrifugal casting, as opposed to static casting, include: *improved uniformity of wall thickness; finer grain structure and higher density; lower finishing and machining costs . . . resulting from improved dimensional control.*

We are equipped to produce horizontal sand and permanent mold castings in sizes from 3½" to 20" O. D. up to 96" in length; in vertical permanent mold from 20" to 34" O. D.

Write for the new Centrifugal Casting Bulletin, or call your nearest Electro-Alloys Sales Office. Electro-Alloys Division, 2086 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

Low Alloy Steel for High Temperature Applications

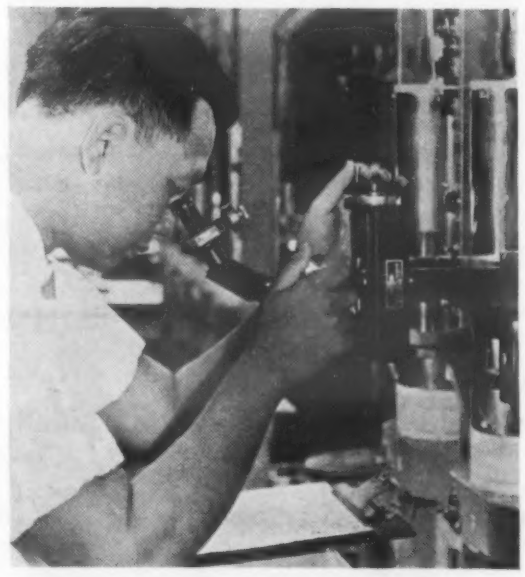
Development of a ferritic or relatively low alloy steel for high temperature applications has been announced by *Crucible Steel Co. of America,* Pittsburgh. Designated as Crucible 422, the new steel is said to satisfy the design engineer's need for high strength bolts and blades in modern steam and gas turbines. Type 422 contains less than 1% nickel, small amounts of vanadium, molybdenum and tungsten. Its principal alloy content is 13% chromium.

According to the company, the ferritic steels have several advantages over the austenitic types, including lower thermal coefficient of expansion, better thermal conductivity, and higher damping capacity.

Crucible 422 meets the following standards for a satisfactory ferritic steel for service above 1000 F:

1. Stress rupture and creep strength at least equivalent to those of austenitic steels at 1000 and 1100 F.
2. Reasonable structural stability.
3. Adequate scale resistance.
4. Maintenance of good ductility (workability) at service temperature and at room temperature subsequent to a long period of service.
5. High notched stress-rupture strength at service temperatures.
6. Good combination of room temperature strength and ductility obtainable by heat treatment.

In the company's laboratory, hundreds of samples of various analyses were put to the tests of a minimum standard for steel used to make bolting for turbines and other machinery involving elevated temperatures. Tests focused attention on the 12% class, with other elements carefully balanced to provide the desired strength factor. The combination of tungsten and molybdenum along with vanadium gives the steel good resistance to tempering. Molybdenum appears to have the beneficial effect of maintaining high toughness. The content of chromium provides scale resistance, a main factor in steels that withstand high temperature steam, or products of combustion.



Here a creep strain measurement of the new low alloy steel for high temperature applications is being taken.

Two New Aluminum Alloys

Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh 19, has announced the development of two alloys, highly resistant to corrosion, and designed for use in welded assemblies (such as pressure vessels), tanks and highway transportation equipment. Designated as XA54S and XC56S, the new alloys permit the use of section thicknesses that are approximately one-half or less of any other aluminum alloys commonly used for similar purposes.

Alloy XA54S belongs to the aluminum-magnesium alloy family and has mechanical properties between those of 52S and 56S. Sheet and plate are available in the annealed and intermediate work-hardened tempers.

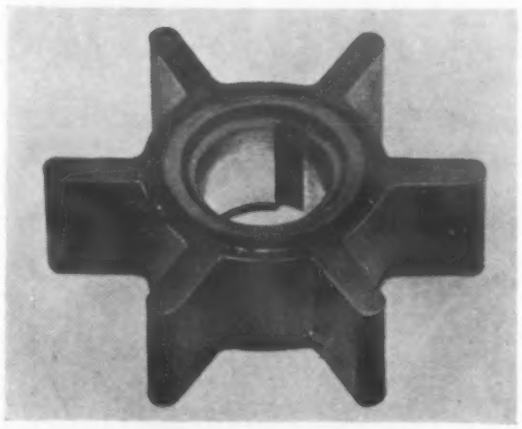
XA54S is said to be well-suited for such applications as: welded ship superstructures and barges; such items as pressure vessels and heat exhanger shells, used in connection with tonnage oxygen plants and the manufacture of fertilizer solutions; and for liquid and bulk hauling equipment such as tank trucks and trailers, dump trucks and other special purpose equipment.

XC56S is similar to the well-known Alcoa 56S alloy used extensively for wire products and venetian blinds, except that the composition has been altered to improve its welding characteristics. It is recommended for general use in the annealed (—0) and hot rolled (—H112) tempers.

The new alloy is suitable for various types of welded structures where strengths higher than those obtainable in 52S and XA54S alloys are required. Commercial evaluation of XC56S has not been carried as far as XA54S, but laboratory tests indicate that in the annealed (—0) and hot rolled (—H112) tempers, XC56S has weld strengths about 25% higher than XA54S in these same tempers.

Both alloys are weldable using inert gas metal arc process (argon tungsten) or semi-automatic inert gas metal arc process. The welds are ductile and have high elongation.

New Materials and Equipment continued



The new rubber-to-metal bonding process has been used here to bond the outer portion to the hub.

Special Process Bonds Rubber to Metal

Advance Rubber Co., Inc., 1702 Washington Ave., N. Minneapolis, Minn., has announced the development of a special process that bonds natural, synthetic or silicone rubber to metal. Reduction of the number of separate parts, and speed-up of assembly and reduced inventory will be of special interest to manufacturers in practically all metal-working fields.

The new method allows parts with metal cores to be ground concentric to tolerances of ±0.002. This cannot be done with rubber alone. Nuts and bushings of rubber and metal can be tightened without breaking, where plastics and fibers would break and leave marks, according to the company. Metal can be used in many rubber items where rigidity as well as resiliency is required.

Valves covered with rubber are said to outperform valves of plain metal. Better seating is obtained at low or high pressures, even where grit is encountered. New synthetic rubber washers in the plumbing industry reduce water absorption, but equal the resiliency of rubber washers. Rubber insert backings on hydraulic cups give support that cannot be obtained by solid rubber.

Practical Method for Electroplating Rhodium

What is said to be the first practical method for electroplating rhodium to thicknesses as great as 0.001 in., thus imparting the properties of pure rhodium to base metals, has been announced by *Technic, Inc.*, Box 965, Providence 1, R. I. In the past, rhodium plating has been limited to thin, porous flash deposits of 1 to 10 millionths of an inch.

The new method employs company rhodium plating solutions. In general, the company recommends that use of rhodium be considered wherever extremely corrosive conditions are encountered. In view of the metal's resistance to all acids, alkalis and most corrosive chemicals, it can be used for plating laboratory instruments, electronic components, high purity pharmaceutical process equipment and chemical process equipment.

Specific applications recommended are in the production of relays, tubes, tuned lines, moving contacts, switches, printed circuits, inductance tuners, safety devices, decorative finish, and tarnish-proof reflectors and mirrors. Introduction of the new method also suggests many applications in the electronic and electrical industries to solve problems that now face design engineers. Such applications have already proved their worth in England, but have not as yet been thoroughly investigated by the United States.

Seamless light-wall tubing up to 2 1/16-in. O.D. is currently being offered.

Seamless Light-Wall Tubing Offered In Large Sizes

Superior Tube Co., Norristown, Pa., has announced an increase in the size range of its seamless light-wall tubing from 1¼ in. O.D. max. to 2 1/16 in. O.D. max. Heretofore, specialty tube mills have offered the larger diameter light-wall tubing only in welded grades. The increased size range is expected to increase the number of applications of light-wall tubing, particularly where pressures exceed the limits for welded tubing.

Present applications include bellows for industrial and aircraft instruments, flexible metal hose for the aircraft, food and chemical industries, and low pressure heat exchanger tubes.

Superior's large diameter tubing is furnished in three stainless analyses—AISI Types 304, 321 and 347—and in monel metal. It is produced with a pickled or standard bright finish and in three tempers: fully annealed, half-hard drawn, and full-hard drawn. Length range is from 5 to 22 ft in random, multiple or cut lengths.

Minimum and maximum wall thickness for various sizes of tubing are as follows:

O.D.	Min. Wall	Max. Wall
to ⅞ in. incl.	0.006 in.	0.035 in.
1 in.	0.007 in.	0.035 in.
1⅛ in.	0.008 in.	0.035 in.
1¼ to 1⅜ in. incl.	0.010 in.	0.035 in.
1½ to 2 1/16 in. incl.	0.010 in.	0.025 in.

Standard O.D. tolerances are +0.005 in., —0.000 in. on tubing up to 1½-in. O.D. exclusive and +0.010 in., —0.000 in. on tubing 1½-in. O.D. to 2 1/16-in. O.D. inclusive. Wall thickness tolerance is 10% on all sizes.

Low-Cost, High Impact Plastic Developed

Im-Plast, a family of new low cost, thermosetting plastics, said to have extremely high impact values over wide ranges of temperature, as well as excellent chemical resistance, has recently been developed by the *Richardson Co.*, Melrose Park, Ill.

Light weight, automotive-type storage battery containers are currently being made from this new material at costs comparable with conventional products being currently used, but with qualities greatly exceeding those of the highest impact containers now available.

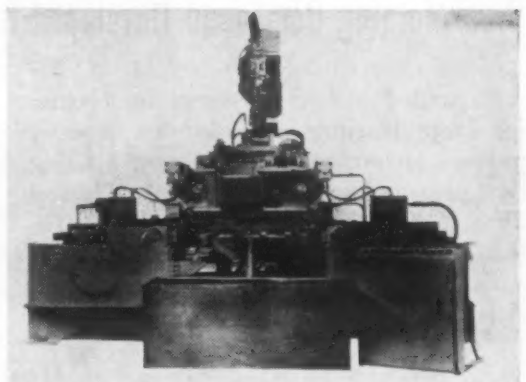
The plastic's qualities of electrical resistance, low water absorption and moldability, combined with its low cost, high impact values and chemical resistance are said to make it ideal material for molding radio cabinets and a wide range of industrial parts.

Welding and Forming Operation Combined in One Unit

Demands for a combination forming machine and welding machine have been answered through the joint efforts of *Struthers Wells Corp.* and *Federal Machine and Welder Co.*, Overland Ave., Warren, Ohio. The unit consists of a Struthers Wells Quadruplex Tangent Bender with a Federal Machine and Welder Co. Welding Component mounted on a beam which is raised and lowered with each machine sequence to make the forming operation possible. The units are presently being produced to form and weld a wide range of appliance cabinets and liners.

In operation, material is first placed in the lower dies of the bending machine and then the operator presses a button to start the fully automatic forming and welding cycle. The bender forms the cabinet to the desired shapes and the last bender operation actuates a limit switch which initiates the automatic welder cycle. At this point, the welder beam is lowered and automatically latched to the male bender die. The welding guns then engage the cabinet and make the welds. The guns retract, the beam unlatches and raises to dwell position. At the time the welding beam starts to retract, the bending wings of the tangent bender also return to their initial position. The cabinet assembly is then automatically lifted to a position where it will easily clear the male die for unloading.

Production costs are said to be materially reduced by an installation of this type compared with conventional methods of forming in a bender and then transferring to a separate weld station. Only one operator is required to perform both operations.



This unit combines welding and joining in one operation.

Vinyl Adhesives Offer Many Advantages

A complete line of vinyl adhesives is currently being manufactured by *Chemical Development Corp.*, Danvers, Mass. Used for bonding vinyl plastics to themselves and to wood, metal, glass, acrylic plastics, cloth, and many other substances, the new materials are easy to apply and do not require heat, pressure, or any special surface preparations. Three products are now available, and each is suggested for a special set of conditions. The resins, solvents and other ingredients have been formulated to produce a quick "bite" or penetration of the surface and a very fast initial tack or bond. One is a mixture of several solvents and penetrants; the others are bodied or slightly viscous solutions which dry to a hard non-tacky coating.

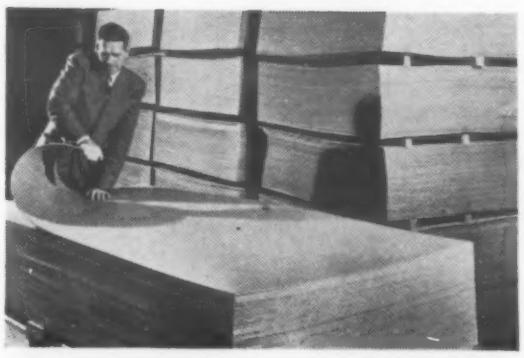
CD Cement #201 consists of several strong solvents and penetrants and was developed specifically for bonding vinyl film to itself. Although fast acting, this material produces a minimum of curl on thin film but still gives a strong bond.

CD Cement #202 is a bodied or slightly viscous adhesive intended primarily for bonding vinyl film to itself. It has a very quick initial bond and is of particular value where fast assembly is essential or for use on rough or poorly-mated surfaces. It has already proved of great value for cementing seams on bags and curtains and many similar applications.

CD Cement #203 is an extremely versatile adhesive for bonding vinyl plastics to metal, glass, paper, leather and other surfaces. It is said to produce a quick initial bond and to be very fast setting. This is a bodied adhesive and is easily applied by brush, machine, or other conventional methods.

New Materials and Equipment continued

High-Strength Hardboard Announced



Flexibility of the new high-strength hardboard is demonstrated here.

Volume production of a new high-strength hardboard panel with extreme flexibility has been announced by *Anacortes Veneer, Inc.*, Anacortes, Wash. According to the company, laboratory tests on initial production show the panel called Armorbord has a degree of shock resistance unparalleled in the board field and it is so flexible, a strip of board ⅛-in. thick can be bent into a right circle about the size of a hatband without cracking the surface.

The board's unusual resistance to impact is said to make it ideal for such punishing jobs as crating. Its high flexibility makes it particularly useful wherever curved surfaces are required in product manufacture. Also suitable for established applications in the building field, like underlayment for floors, wall paneling and cabinet work, Armorbord in the ¼-in. thickness is highly stable under changing moisture conditions, and its physical properties exceed all minimum government specifications for standard hardboard.

Made in ⅛-, 3/16- and ¼-in. thicknesses, the board is light tan with a hard, satiny surface—good for painting and highly resistant to wear.

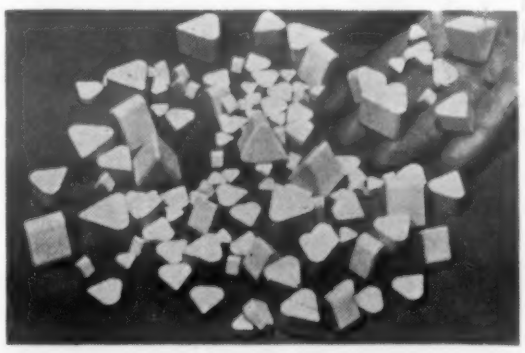
Urea Molding Compound Developed for Housings

Expanded use of thermosetting plastics for large housings in color are forecast in an announcement of a new housing type urea molding material by the *Plaskon Div., Libbey-Owens-Ford Glass Co.*, Toledo 6.

According to the company, the material has proved itself superior to previous urea molding compounds produced for this type of application, particularly for radio cabinets and clock cases. It is said to be readily moldable, and in molded form to have superior quality and surface appearance and greater luster than compounds formerly used in this type of application. The new material is non-electrostatic, high in dielectric strength, scratch resistant and noncombustible.

The announcement of the housing type material appears simultaneously with Plaskon's announcement that its urea and melamine molding compounds are available in the 29 popular House & Garden Colors for 1953.

Ceramic Tumbling Media for Finishing Materials



This new ceramic tumbling media is being used in a variety of deburring and tumbling applications.

Crown Pebs, a newly developed tumbling media for barrel tumbling, de-burring and finishing, have been introduced by *Crown Rheostat & Supply Co.*, 3465 N. Kimball Ave., Chicago. They are currently being used in a various assortment of deburring and tumbling operations.

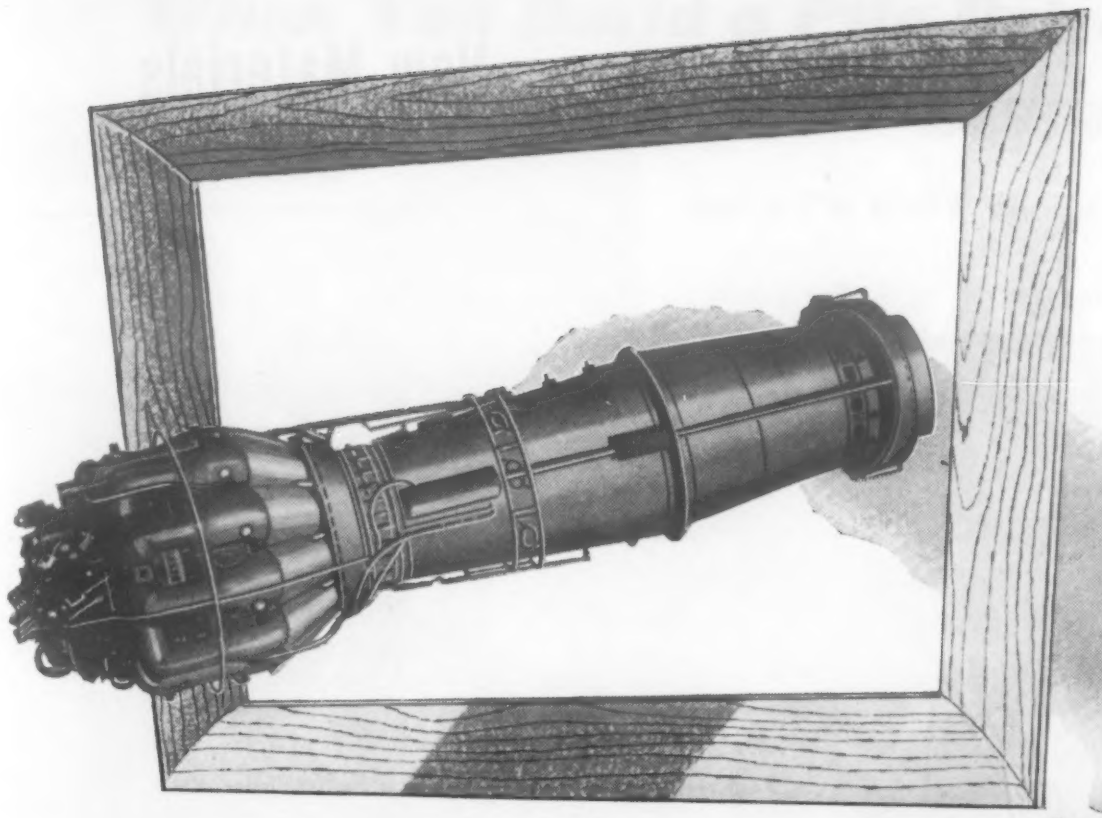
The Pebs, made of tough, white ceramic, are of uniform size and triangular shape. They are available in a variety of sizes. By selecting the proper size, the lodgement hazard encountered when conventional random-shaped natural or synthetic stone chips lodge in holes and slots is said to be eliminated. This, in turn, eliminates the need of an extra operation to remove the lodged material. The uniform shape and density of the chips produce uniform processing results.

According to the company, the tough, wear resistant ceramic used in the manufacture of the media insures a service life several times longer than either natural stones or aluminum oxide type of tumbling chips.

New Melamine-Glass Mat Laminate

Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York 17, has developed a new melamine-glass mat industrial laminate, Grade 115. The new product has most of the physical characteristics of Panelyte's Grade 140, but is less expensive. It is made from a glass mat base; Grade 140 (Type GMG) is made from a continuous woven glass cloth. According to the company, Grade 115 can be used as a substitute material for most applications previously requiring Grade 140.

Physical data for the new industrial grade according to MIL-P-15037A test methods are: arc resistance, 182 to 186 sec; density, 1.71 to 1.73 gr per cc; water absorption, 2.8 to 3.4%; impact, 3.96 to 4.13 ft-lb per in. notch; flexural, A, 14,500 to 16,000 psi; bonding, A, 1135 to 1435 lb.



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*FROZEN MERCURY INVESTMENT CASTING

● Do you ever feel that your creative engineering is hampered by limits imposed by traditional metal-working processes? Then investigate the production process that takes over where the others leave off! Learn about the greater design freedom and production economies available through mercastings by Alloy Precision.

With this advanced method, surface finishes can be cast from 125 to 60 micro-inches . . . dimensional tolerances can be held to ±.003″/inch. These, of course, depend on mass and material. *In many applications, mercastings require no machining.*

Frozen mercury patterns melt out of the mold permitting one-piece castings of amazingly complex contours and interior cavities. Thus, what would otherwise be an assembly of machined parts, can often be mercast as a unit.

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1. too difficult or too expensive to machine

2. too large or too intricate for lost wax casting

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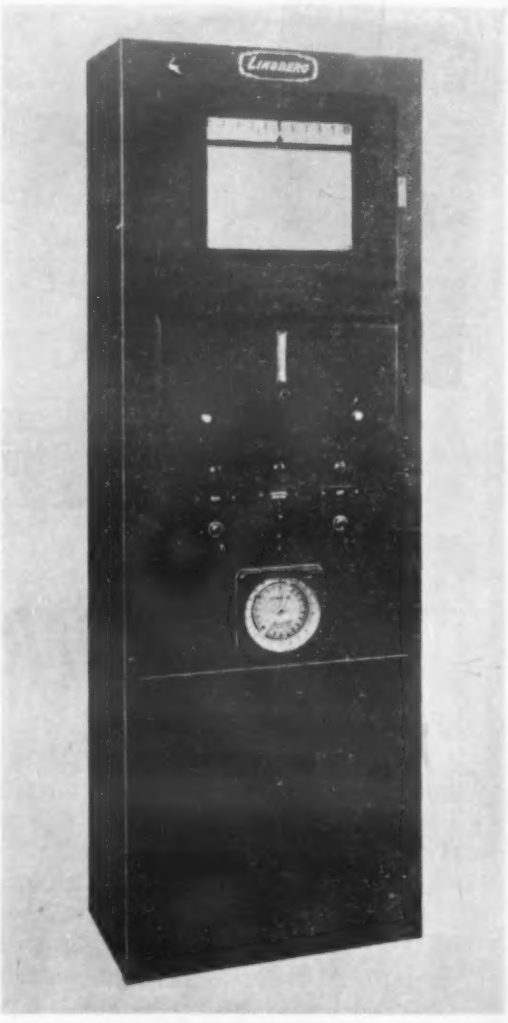
New Materials and Equipment



New Unit Automatically Controls and Records Carbon Potential of Furnace Atmosphere

Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, has announced the development of a new device to automatically control and record the carbon potential of furnace atmosphere. A proportioning instrument, the Carbotrol enables the heat treater to set his atmosphere or furnace in equilibrium with any steel.

The heat treater merely sets the pointer on the control instrument for the carbon content of the steel he wishes to treat in exactly the same manner he sets his pyrometer for the temperature of the steel. The Carbotrol automatically controls the atmosphere generator to produce a protective atmosphere in equilibrium with the steel. For example, if the heat treater desires to heat treat a 1.20% carbon steel free from decarburization and scale, he sets the unit instrument to a 1.20% carbon potential. The instrument automatically adjusts the air-gas ratio on the atmosphere generator to produce an atmosphere in equilibrium with the 1.20% carbon steel and continuously records the results. If the next lot of steel to be heat treated is, on the other hand, only a 0.30% carbon, he merely sets the pointer on the instrument to 0.30%

When You Build a Pile Driver - You Need

DEPENDABILITY

THAT'S WHY McKIERNAN-TERRY SPECIFIES

MEEHANITE® CASTINGS

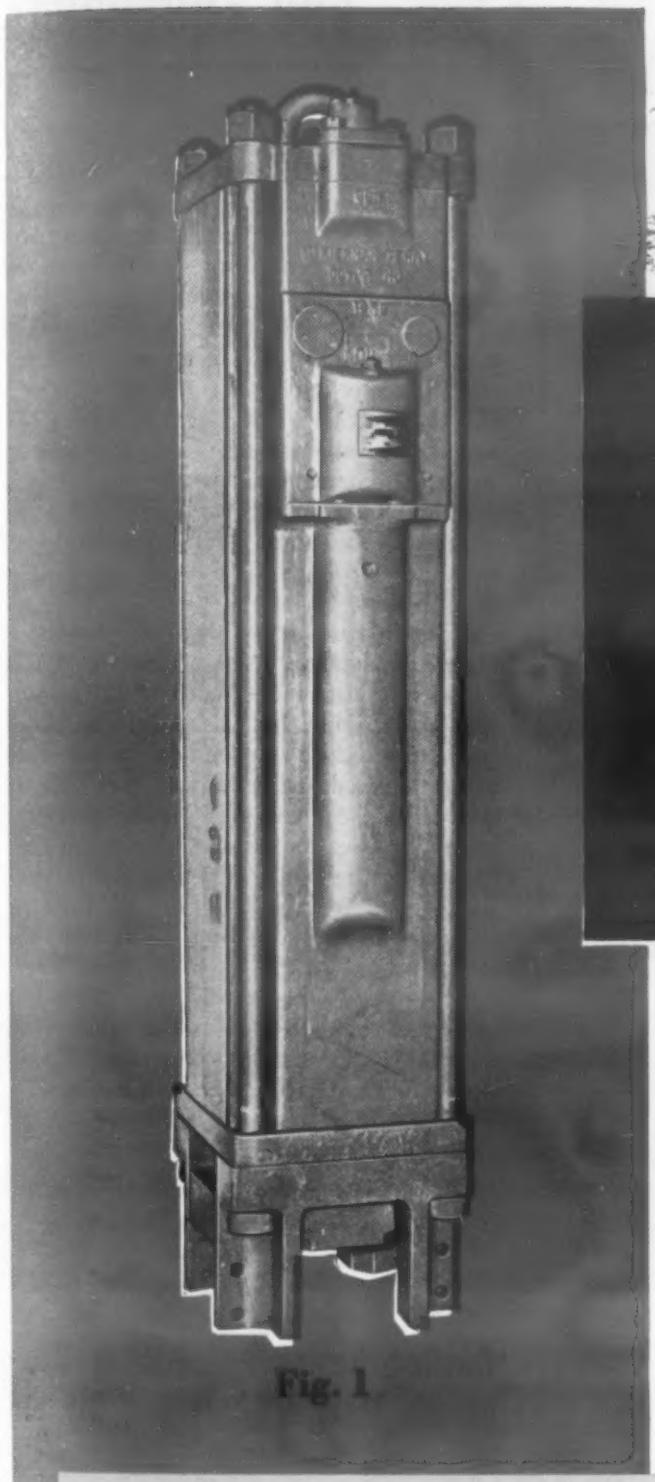


Fig. 1

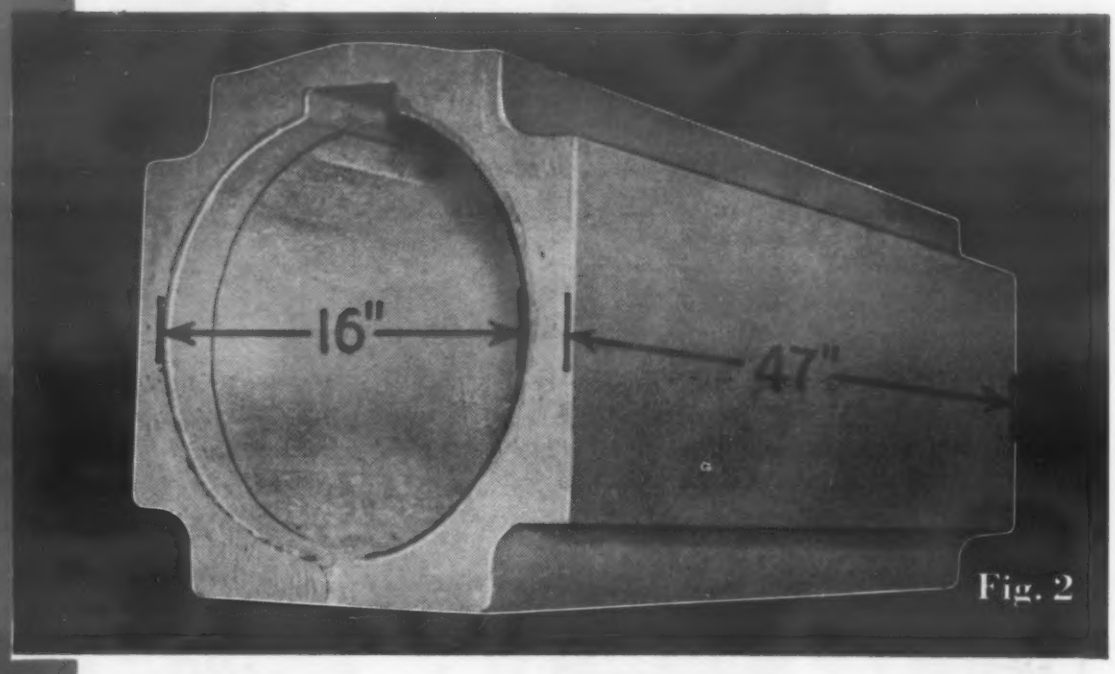


Fig. 2

In the pile driver illustrated (Fig. 1), built by McKiernan-Terry Corporation, Dover, New Jersey, the severe working conditions imposed upon such units require complete dependability in operation. The top and bottom (Fig. 2) cylinders are vital units in the functioning of the equipment and must be dense, pressure tight, strong and machinable. Both cylinders are Meehanite castings, each weighing about 2,000 pounds.

Meehanite castings regularly meet the rigid specifications for these components.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
De Laval Steam Turbine Co.	Trenton, New Jersey
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
London Concrete Company, Ltd.	Brantford, Ontario
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
Palmyra Foundry Co., Inc.	Palmyra, New Jersey
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

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NEW ROCHELLE, N. Y.

New Materials and Equipment

carbon potential, and the generator is automatically controlled to produce an atmosphere within minutes to be in exact equilibrium with this steel.

The Carbotrol is also said to eliminate the headaches of operating an endothermic generator on a raw gas supply, such as manufactured gas, which varies in analysis throughout the day. The instrument automatically corrects the air-gas ratio of the generator to produce a constant dew point, or carbon potential endothermic atmosphere as the raw gas supply and pressure varies.

Used in conjunction with the Lindberg Hyen atmosphere as a carrier gas, the Carbotrol instrument automatically controls carburizing and carbonitriding processes to produce the carbon in the case to any desired specifications. Not only is the carbon content said to be precisely controlled, but soot is also eliminated during the entire cycle, and thus the carburizing cycle is greatly shortened for any case depth and cleaning operations are eliminated.

The new instrument is currently being subjected to extensive field application tests and is expected to be ready for production in approximately six months.

Casting Resins and Potting Compounds Meet Military and Civilian Needs

A new line of casting resins and potting compounds to meet today's needs of military and civilian users has been announced by *Carl H. Biggs Co.*, 11616 W. Pico Blvd., Los Angeles 24. According to the company, increased design and production problems now found in the trend to miniaturize design has made it necessary to develop casting resins and potting compounds of much higher quality than previously available.

When used for cast-resin embedments of circuits and components, Helix potting compounds are said to provide hermetic-sealing protection against moisture, fungus, fumes, etc., and offer rugged protection against shock and vibration with considerable elimination of mounting hardware and consequent reduction of labor time and costs, since bare point-to-point wiring can be used.

The resins are claimed to have extremely low shrinkage—less than 1%—with excellent adherence to metal leads and other elements. Corrosive effects are said to be nil. Supplied in liquid form,

Now

. . . you can change resistance welding die set-ups in a matter of seconds . . .

with the new

MALLORY "*Nu-Twist**" DIE ADAPTOR

It's just as easy as it sounds, too. By using different electrode inserts in the "Nu-Twist" die adaptor you can handle several resistance welding jobs with only one die set-up. You can change from one job to another in a matter of seconds . . . without switching basic dies . . . without tools.

Mallory "Nu-Twist" die adaptors save set-up time and reduce die inventory. They are especially well suited for shops that have small run resistance welding applications such as projection welding, single spot welding and electrical upsetting. They are designed so that all the operator has to do is turn the locking nut by hand, slide out the electrode insert, slip in the one for the next job and turn the locking nut. The entire operation is as fast and simple as that.

Die adaptor bases are custom designed to fit your machine specifications and a wide variety of standard electrode inserts are available from stock. Special shapes and sizes can be designed to fit any requirements. For complete data, either write us or call your Mallory distributor and ask for a copy of Technical Bulletin 8-22. It's just off the press.

Expect more — Get more from **P. R. MALLORY & CO. Inc. MALLORY**

In Canada, made and sold by Johnson Matthey and Mallory Ltd., 110 Industry Street, Toronto 15, Ontario.

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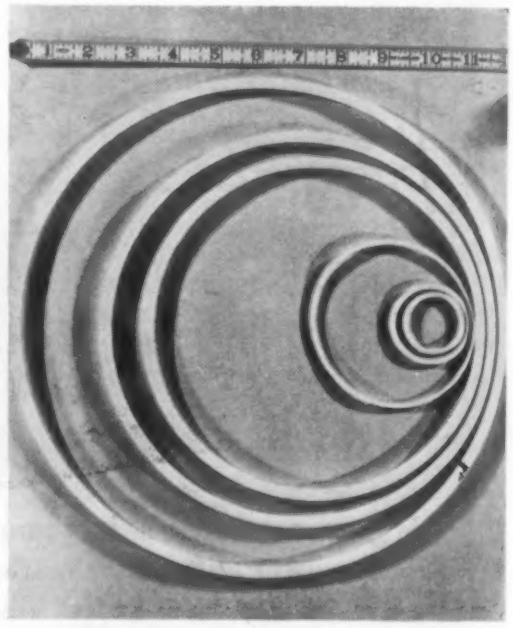
For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

New Materials and Equipment

Helix resins are poured cold and will cure at room temperature. They are 100% resin solids compounds which give a nonporous casting with a temperature range of from —100 F to 400 F with very slight changes in their electrical or physical properties. Moisture absorption is less than 0.01%, and excellent humidity chamber tests have been recorded. The resins are also unaffected by acids, alkalies and carbon hydrates.



Synthetic O-Rings Withstand Unusual Service Conditions

W. S. Shamban & Co., 5747 Marilyn Ave., Culver City, Calif., has announced production of three new series of Kelon-T (Teflon), Kelon-F (Kel-F, Fluorothene), nylon and polyethylene o-rings for special sealing applications where elastomeric (rubber) o-ring compounds are unsatisfactory. According to the company, the o-rings offer many desirable properties previously unattainable in ordinary o-rings such as heat resistance, chemical inertness, and low coefficient of friction. They are said to be unaffected by oils, acids, bases or solvents. Useful temperatures range from —110 F to 500 F for Kelon-T o-rings, and 425 F for Kelon-F o-rings.

The new synthetic o-rings are also claimed to successfully resist new hydraulic fluids and missile propellants now being introduced for use in power plant and fuel systems of jet engines and guided missiles. Recommended for hydraulic, food processing, chemical, petroleum, pump, valve, aircraft and missile

Glass keeps market for bubblers "bubbling"

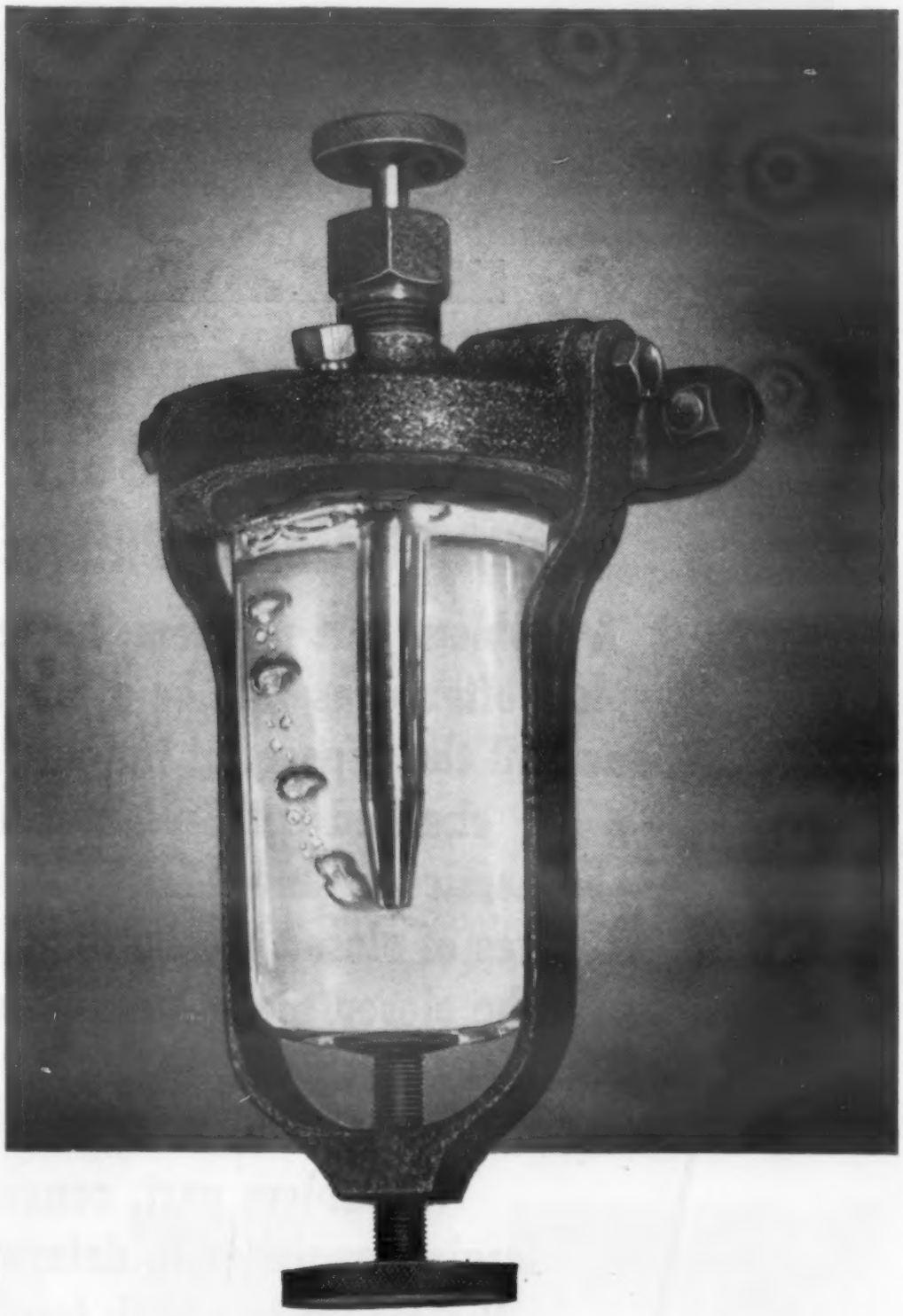
Another example of how glass by CORNING improves product performance

Bubbles aren't too solid a foundation on which to build a business but they have worked fine for The Meriam Instrument Co.

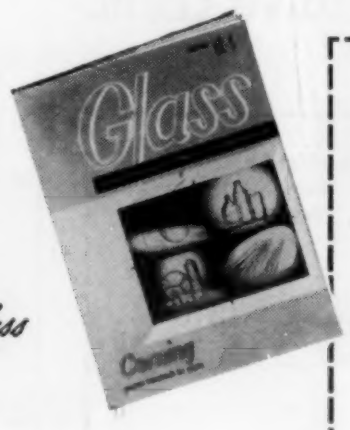
They manufacture Sight Feed Bubblers. At first, they were used for the continuous operation of tank liquid level gauges. Then, Meriam saw a much wider market for this product —to purge lines, give visual indication, note the presence of harmful gases and in conjunction with flow meter measure of corrosive materials, to eliminate the problem of satisfactory sealing fluids.

To make Sight Feed Bubblers adaptable for all of these services, Meriam engineers got in touch with Corning. Out of this came transparent corrosion-resistant PYREX bowls made to close tolerances for operation up to 50 psi. Noted for its resistance both to corrosion and thermal shock, PYREX brand glass No. 7740, provides an economical solution to the problem.

Doubtless your problem *is* different. But if glass in any shape or form can help to solve it, check with Corning. As a means of bringing you up-to-date on glass, we'd be happy to send you "Glass, its increasing importance in product design." It contains a digest of the characteristics and types of glass available with useful tabular data. Use coupon below.



Send for this 12-page illustrated idea book, "GLASS—its increasing importance in product design." The coupon is for your convenience.



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Company_____

Address_____

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New Materials and Equipment

installations, the o-rings provide new design possibilities for engineers and designers presently limited by currently used materials.

Sizes of Kelon-T series ST-2672 o-rings and Kelon-F series SF-2672 o-rings correspond to those of AN 6227 o-rings; series ST-2603 and series SF 2603 correspond with AN 6230; and series ST-2609 and SF-2609 correspond with AN 6290. Other sizes upon request.

High Flash Point Emulsion Cleaner Developed

Pennsalt EC-54, a new type of emulsion cleaner which will not boil off, evaporate or flash at use temperatures, has been developed for metal cleaning by the *Pennsylvania Salt Manufacturing Co.*, 1000 Widener Bldg., Philadelphia 7.

According to the company, EC-54 will clean nonferrous metals without tarnishing and will protect ferrous parts from in-plant rusting. In extensive field tests, one of them in a large airplane engine plant, this product is said to have proved outstanding in its ability to remove tough soils from difficult-to-clean parts.

The new cleaner, an emulsifiable liquid, has a flash point of 260 F, a fire point of 300 F, and 95% boils within a range of 500 to 600 F. Therefore, it will not boil off or evaporate when used at high temperatures in a power washing unit. Its flash point is well above temperatures normally used in emulsion spray cleaning.

Particular advantages from these characteristics are that there is negligible loss through evaporation; no solvent vapors condense on plating tanks; the fire hazard is minimized during shut-downs or in drains or sewers; and the cleaning solution can be used at higher temperatures to assure maximum detergency on high melting point soils.

Ferrous parts cleaned with EC-54 are protected against in-plant rusting for a period of one to six weeks. This period can be lengthened by the use of a stronger solution and by omission of the rinse following the cleaning stage.

On nonferrous metals, it is claimed not to tarnish aluminium, magnesium, brass or zinc. One cleaning unit can be used to process all metals in a given plant.

The company recommends the use of the cleaner in power washing units at a concentration of from 1-to-20 to 1-to-100 with water, at a pressure of from 15 to 60 psi, at a temperature of from 160 to

For copper in any form – For top-notch service – Call Chase

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What kind of copper or copper alloy do you need? Free-cutting brass rod? Sheet and strip brass? Phosphor bronze for springs? Call your nearby Chase warehouse. We can supply you, subject to government controls, with the widest variety of brass or copper materials for production, maintenance or repair.

Many of our branches are equipped to slit, saw, or shear our metals or your own stocks to specifications.

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Baltimore	Dallas	Kansas City, Mo.	New Orleans	Rochester†	
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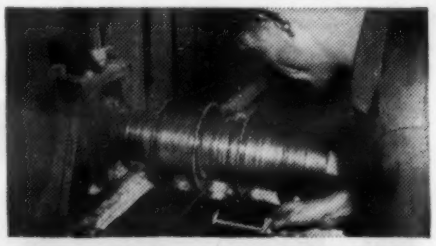
Deliveries to your factory by truck, rail or express, if desired.



Close tolerance sawing, slitting, shearing to your specifications.

Stocks of tube, rod, bar, strip, sheet and wire in a variety of alloys.

New Materials and Equipment

200 F, for from ¼ to 2 min. For added detergency, alkaline cleaners can be added to an EC-54 spray washing solution. For nonferrous metal cleaning, ⅛ to 1 oz per gal of a mild alkaline cleaner, such as Pennsalt A-10, can be used, and for nonferrous metals alone, ⅛ to 1 oz per gal of Pennsalt #30 is recommended for extra cleaning action.

The new cleaner is recommended for precleaning in plating and porcelain enameling cycles, for cleaning prior to painting and phosphatizing, for cleaning for inspection, and other similar cleaning uses.

Semi-Portable Degreaser for Small and Medium Size Parts

A new Detrex VS Jr degreaser has been announced by *Detrex Corp.*, Detroit 32. The highly efficient compact unit is designed to clean small and medium sized parts and is ideally suited for shops, laboratories and small manufacturing plants where production up to 600 lb of steel per hr must be degreased.

Two standard, manually operated models of the unit are available. One is electrically heated, the other operates by steam. Both can be easily relocated at any time in various work areas as long as service facilities are available.

The VS Jr operates on the same long-established company degreasing principle —parts are suspended in pure solvent vapor which rapidly dissolves soils of dirt and grease. A spray of hot solvent quickly flushes away any loose stubborn soils that might remain. Finally, a rinse in pure solvent vapor leaves the work thoroughly clean and dry.

All work can be placed in baskets or on racks or hooks for quick, easy handling. Work can be carried in and out of a degreaser either by hand or a small hoist. The equipment is only 48 in. from

5 Reasons Why Foundries Everywhere are Buying the New Pangborn Blastmaster Barrel

Erie Bronze Co., Erie, Pennsylvania, bought the Blastmaster for rapid cleaning of bronze castings.

Alfred Heller Heat Treating Co., New York, N. Y., selected the Blastmaster for efficient removal of steel scale.

Reddin Iron Works, Syracuse, N. Y., chose the Blastmaster to clean its large output of gray iron.

Emsco Derrick & Equipment Co., Los Angeles, California, purchased the Blastmaster to speed its cleaning of castings.

Elliott Co., Jeannette, Pennsylvania, picked the Blastmaster for thorough cleaning of its production of gray iron castings.

Pangborn's new Blastmaster ROTOBLAST® Barrel is making new friends—and customers—everywhere, as word gets around about its amazing versatility! Bronze . . . gray iron . . . non-ferrous castings . . . forgings . . . the Blastmaster cleans 'em all, faster, cheaper and better! That's because this new barrel uses famous Pangborn ROTOBLAST that does a better job and saves you money these five ways:

SAVES LABOR with push-button operation
SAVES SPACE because machines are compact
SAVES TIME by cleaning more loads per day
SAVES POWER since no compressor is needed
SAVES TOOLS because all scale is removed

If you're interested in better, faster, cheaper blast cleaning, you owe it to yourself to find out more about the Pangborn Blastmaster Barrel. Available in 4 sizes—3, 6, 12, and 18 cu. ft. capacity. For more details, write for Bulletin No. 223 (Blastmaster Barrel) or No. 214 (all ROTOBLAST equipment), to: PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Maryland.

OVER 28,000 PANGBORN MACHINES SERVING INDUSTRY

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment

Pangborn

BLAST CLEANS CHEAPER

with the right equipment for every job

New Materials and Equipment

the top to the base, affording a low, convenient working height. The interior of the equipment is coated with Detrex FF-1, the new nonporous coating which is completely corrosion proof and unaffected by degreasing solvents.

According to the company, the new unit is extremely economical. It is low in initial cost as well as in operating and maintenance cost. Installation is simple and inexpensive. Just attach the water supply and plug in the electric model, or connect a steam line to the steam operated model.

New Resin for Sand Core Bonding

A new phenolic type liquid resin for sand core bonding has been announced by *Durez Plastics & Chemicals, Inc.*, North Tonawanda, N. Y. Advantages claimed for the new product are: longer storage life, lower cost, excellent bond strength and low volatility.

Known as Durez 16039, the material is soluble in water, but upon curing either in ovens or dielectric dryers, the resulting cores have good water resistance. It is said that cores made with the new resin have proved suitable for use in making castings from aluminum, bronze, gray iron, malleable iron and steel.

Corrosion Resistant Phenolic Resin Coatings

Ric-Wil Plastic Coating & Manufacturing Corp., 1290 Euclid Ave., Cleveland 15, has announced availability of phenolic resin coatings specially formulated to protect equipment against extremely corrosive conditions in all types of industry with a tough, impervious film which is said to be resistant to attack by corrosive acids and alkalis, salt water, rust and weatherings. The coatings are expected to provide good protection for ventilating and duct systems, drill pipe, piping and equipment in food, chemical process plants, oil refineries, pulp and paper plants, sewage lines, tank cars, storage tanks.

At the present time, two distinct types of Ricwilite coatings are available:

Ricwilite 1060 phenolic resin coating is of the baking or heat-hardening type.

Why Westinghouse specifies DUROID 700 for tap changer support

NO BLISTERED PIECES • HOLDS SHAPE

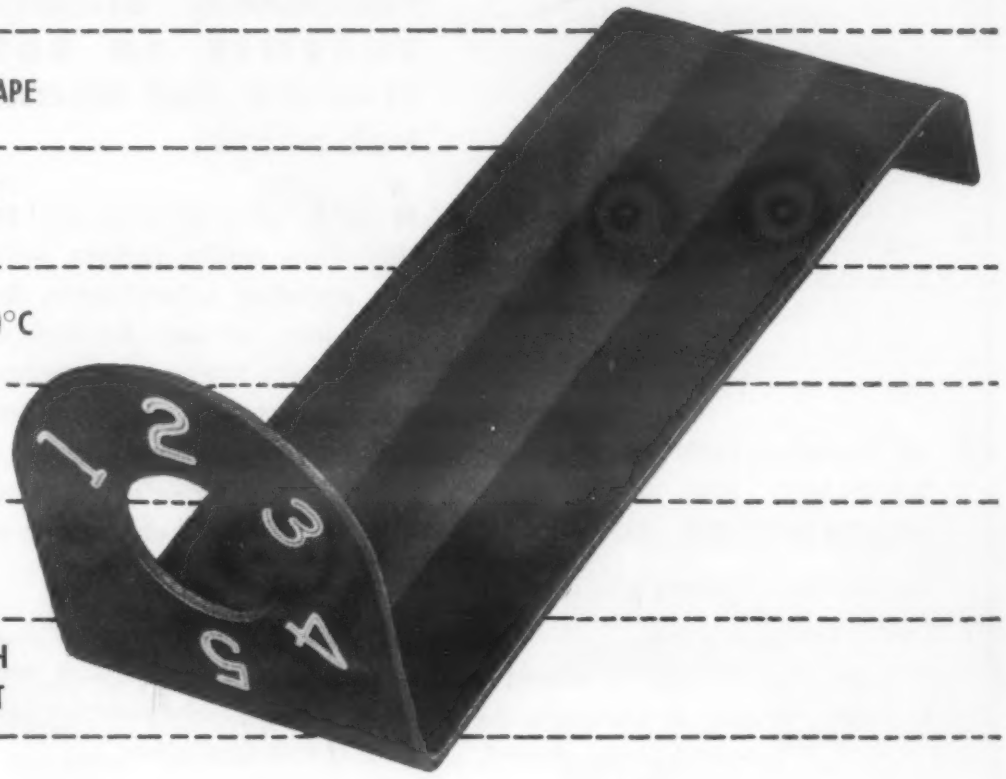
LITTLE DANGER OF MOISTURE PICK-UP BETWEEN BAKING AND OIL SUBMERSION

MECHANICAL STRENGTH MAINTAINED IN OIL AT 90°C

STAYS FIRMLY FASTENED TO PORCELAIN WITH SELF-TAPPING SCREWS

FORMS INTO THIN-SECTIONED RIBS OF HIGH STRENGTH

NUMBERS CAN BE MARKED TO SHOW THROUGH TRANSFORMER OIL WITHOUT CONTAMINATING IT



You name it— we'll make it— and fabricate it, too.

IN DUROID 700 Westinghouse found a fibrous material that provided a vastly improved support for the tap changer in one of its distribution units. Listed by Underwriters Laboratories, this Duroid is one of many specially processed fibrous materials developed by Rogers. Several steps above conventional fibrous products, it combines rigidity and firmness with non-brittleness. In its ability to outperform standard non-metallic sheet materials in its class, Duroid 700 typifies the special work Rogers is doing with fibrous sheet products. Rogers may have—or can develop—just the material you need to effect a design improvement. We will not only provide the material, but fabricate finished parts as well.

CATALOG Complete data about DUROID 700 and other Rogers Duroids are available. Please write to Dept. M, Rogers Corporation, Manchester, Conn.

Better Parts for Better Products

ROGERS CORPORATION

Established in 1832

DUROIDS	ELECTRICAL INSULATION	PLASTICS	SHOE MATERIALS	FABRICATING
for Gaskets, Filters, Electronics . . .	for Motors, Transformers, Generators . .	Molding Compounds and Laminates	for Counters, Midsoles, Liners . . .	Producing parts from Rogers materials

New Materials and Equipment

When baked at 350 to 400 F, the coating hardens or polymerizes to form a chemically inert, insoluble, corrosion resistant coating—hard and tough, glass-like in appearance, yet flexible and elastic.

Ricwilite 7100 is of the cold-setting type which is cured or polymerized at room temperature (60 to 80 F) by the addition of a catalyst just prior to application. It can be applied to almost all metals, concrete, wood and plaster surfaces by brush or spray.

Tungsten Carbide Ball Mills Have Increased Life

American Electro Metal Corp., Yonkers, N. Y., has announced the commercial availability of improved ball mills for the manufacture of fine powders, particularly of metals, ceramics and other hard materials.

Ordinary ball mills are claimed to wear out rather rapidly, particularly when used for the grinding of abrasive material. This not only reduces the life of the mill, but also leads to a contamination of the resulting powder with particles picked up from the mill.

Longer life of the ball is insured by the use of tungsten carbide liners, as compared to unlined steel, iron or other alloys. Because of the inherent resistance of tungsten carbide to abrasion, contamination of the powders being milled by the ball mill is greatly reduced and often completely avoided.

The new ball mills are available, on customer's specifications, in sizes up to 12-in. I.D. and 15 in. high, with standard assortments of tungsten carbide balls.

Ionic Paint Spraying Equipment Produces Even Finish

Scientific Electric, Garfield, N. J., has announced the development of new ionic-high potential paint spraying equipment. A feature of this equipment is the ionic gun. The spraying unit was designed on a principle of charging the paint electrically within the spray apparatus itself. Older installations required the use of an external electrically charged screen which did not give uniform ionization of paint

New Materials and Equipment

spray, with the result that these units were only efficient for painting flat or smooth surfaces.

With the ionic gun, paint is claimed to be highly ionized so that it differentiates between painted and unpainted surfaces, producing an even finish and penetrating into all cavities and crevices. As a consequence, less paint is used in actual operation and product quality is increased significantly.

Stud Heater Provides Quick Heat

A new heavy-duty electric heater designed to preheat large studs that are used to clamp large castings together on heavy equipment has been announced by *Edwin L. Wiegand Co.*, 7523 Thomas Blvd., Pittsburgh 8.

Quick heat is provided at the assembly point with the portable electric heating unit. In order to tighten the nuts securely, the studs must be lengthened temporarily. This is done by drilling a hole through the stud and inserting the stud heater in this hole. The stud then expands lengthwise, allowing the nuts to be tightened more than would be possible if the stud were cold. When the heater is withdrawn and the stud cools, a very tight fit is said to result—in the same manner that rivets tightly joined structural steel members.

The heater consists of alloy-sheathed Chromalox electric tubular units fitted in a gun-shaped stainless steel holder. The handle grip aids extraction of the heater. Various sizes and ratings are available to accommodate studs of different sizes. Standard lengths range from 10 to 70 in.; capacities from 2 to 12 kw; and outside diameters from about ½ to 1 in.

Tumbling Barrel Boosts Production

A flask-type, direct motor drive, tilting tumbling barrel developed by the *Hupp Corp., Globe Div.*, 1250 W. 76th St., Cleveland 2, is said to be giving better

New Materials and Equipment

work action for deburring and burnishing of all types of precision parts both ferrous and nonferrous.

According to the company, the machine can be employed with all types of deburring and burnishing media and is available in sizes for loads ranging to 750 lb. The flask-type barrel is constructed of continuous welded sections of heavy steel plate. A ¼-in. lining of abrasion resistant rubber or neoprene vulcanized to the barrel provides effective insulation to give longer life to the barrel shell while protecting parts against nicking and scratching. Use of the lining permits the barrel to be used interchangeably for deburring and burnishing.

Direct drive is provided with a 1-hp motor mounted directly above the worm segment for balance and space economy. The units are available with either single or variable speed motors which drive the barrel through a gear reduction, permitting maximum power to the barrel without overtaxing the motor.

Design of the new barrel is said to concentrate the load into a smaller working area, which increases the efficiency of the tumbling action. The tilting angle of the barrel can be adjusted to produce a smooth, tumbling action or a more violent one. By tilting the barrel to its horizontal axis, maximum agitation is obtained. As the barrel is raised towards its vertical axis, the violence of agitation is diminished for smoother action. Speeds of the flask-type barrel are available as low as 17 rpm for nonferrous and plastic parts to eliminate spoilage. Standard equipment includes variable speed motors to give speeds of from 10 to 35 rpm.

Liquid Rust Inhibitor for Wet Blasting Machines

American Wheelabrator & Equipment Corp., 1148 S. Byrkit St., Mishawka, Ind., has announced the development of Anarust, a liquid rust inhibitor for wet blasting machines. Anarust is a material of organic composition and contains no chromates. It is said to be completely soluble in hard or soft water at 20 C and to produce a clear colorless solution, which is odorless, nonirritating to the skin and not subject to bacterial decomposition. It produces no foaming when put into solution, and keeps water stain-

(*Continued on page 149*)

ing to a minimum on ferrous parts which are rinsed in it. Its specific gravity is about 1.0 at 20 C.

When used at the rate of approximately ½ oz per gal of water, it is said to be a very effective agent in retarding rusting on cast iron or steel parts which are being cleaned and washed after wet blasting. It can also be safely used on parts prior to undergoing such operations as plating, enameling, painting, etc.

Investment Casting Furnace For Jet Engine Parts

To meet the need for an efficient method of producing precision castings, especially in the jet aircraft field, the *Detroit Electric Furnace Div., Kuhlman Electric Co.,* Bay City, Mich., has introduced the Type LC, 12-kw, 10-lb, indirect arc electric furnace. The furnace consists of a melting chamber and transformer combined into a single unit. The melting chamber has a 2-piece refractory seated in a granular insulation and is provided with tubular entrances for electrodes and for pouring. The investment mold clamps onto the shell face plate by means of compressed air.

The transformer is a 17-kva adjustable reactance, Class B, dry type, available for either 220 or 440 volts, 60- or 50-cycle, single-phase supply.

The operator pours the heat by simply inverting the furnace and allowing the molten metal to run into the clamped-on mold. As soon as the casting has solidified, the operator releases the air pressure

New Materials and Equipment

and removes the mold before returning the furnace to the melting position.

An intergrating kilowatt hour meter tells the operator approximately the progress of the heat. An indicating watt meter tells him the rate of energy input.

Average melt time is 6 lb in 9 min. when casting alloy steels of Stellite variety. The average time per heat is 12 min.

Type IC furnace can be used to cast stainless, chromium-nickel heat resisting steels, and super alloys such as are used in jet engine parts.

Insulating Material Has Exceptional Dielectric Strength

Irv-O-Bestos, a new Class "B" insulation consisting of Mylar polyester film bonded to Quinterra asbestos papers in duplex and triplex combinations, has been announced by the *Irvington Varnish and Insulator Co.*, Irvington 11, N. J.

This new type of insulation is said to have not only high tensile and tear strength, but exceptional dielectric strength as well. For example, the 0.003-in. duplex construction has a dielectric strength of 1900 vpm with ¼-in. electrodes, and 1500 vpm with 2-in. electrodes.

Suggested applications for the new material might be as motor and dry-type transformer insulation, magnet wire insulation, coil and relay insulation, sheet insulation, or as primary cable insulation.

Polyester Resin for Glass Fiber Reinforced Products Offered

A new solid polyester resin, Atlac LV, has been announced by *Atlas Powder Co.*, Wilmington 99, Del. After dissolving in styrene, it possesses a viscosity in the low range required for application to glass fibers or other types of preforms by spraying, dipping or brushing. The characteristics of the new resin make it of special interest to fabricators of glass fiber reinforced boats, auto bodies and other large items where low-temperature cure is normally used.

(*Continued on page 154*)

STRETCH OUT YOUR STAINLESS, TOO

There *are* ways to stretch out your supply of stainless.

For example, you may be using a grade or finish of stainless that is in extreme demand when another similar one, not as tight, could do the job adequately.

Our metallurgical staff and stainless fabricating specialists are ready to help you look into this matter and to advise you on more readily-available types of stainless that will do a satisfactory job. Feel free to call on us for this specialized help.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

STAINLESS STEEL

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REZISTAL STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

New Materials and Equipment

Like other Atlac products, the new resin is supplied in the form of free-flowing granules, thus eliminating the inconvenience of premature cure in storage or shipment. When using Atlac LV, sufficient resin for immediate use is easily made up by dissolving it in styrene, so that fresh resin is in use at all times, assuring uniform cure. The product is also said to possess the added advantage of low exotherm with room temperature catalysts.

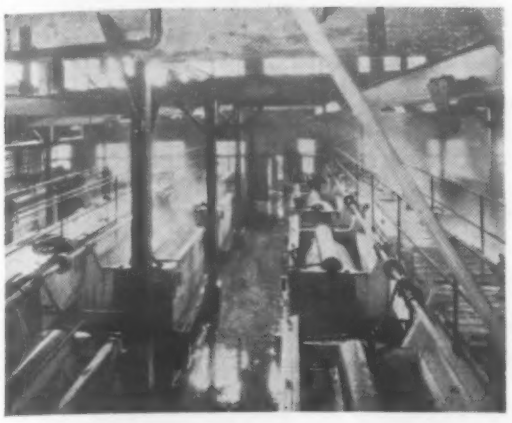
New Alkaline Procedure Removes Oxides from Copper and Copper Alloys

Removal of cuprous and cupric oxides from the surface of copper and copper alloys that have been subjected to high temperatures is a serious problem to industry. Cupric oxide dissolves rather readily in most cases, but cuprous oxide, which is red in color, is attacked by various acid reagents only very slowly. Because of this, industry has employed for years oxidizing acid mixtures that undermine the base copper to free the oxide rather than employing a chemical that will dissolve the oxide itself. Mixtures containing sulfuric acid with chromic acid or dichromates are standard for scale removal from copper. However, this mixture attacks the copper and after the scale has been removed, a deeply etched pattern may be left that mars the finish and makes it difficult or impossible to buff or burnish the surface to a high luster. The procedure is also unsuitable for removing cuprous oxide from thin sections of copper or copper alloys.

A procedure recently developed by *Enthone, Inc.*, 442 Elm St., New Haven, Conn., eliminates the use of acids and the preferential attack on the base metal. This procedure involves converting the cuprous oxide to cupric oxide by the use of Enthone's Ebonol "C" Process. The black cupric oxide that is formed by the use of the treatment is easily removed by means of dilute acids, such as dilute sulfuric acid or sodium cyanide. If the oxide is heavy, the cycle is repeated several times until the clean bare copper alloy surface is exposed. The process has been found applicable to pure copper, tin-bronzes, phosphor bronzes, brasses, and various copper alloys containing silicon and aluminum.

(*Continued on Page 157*)

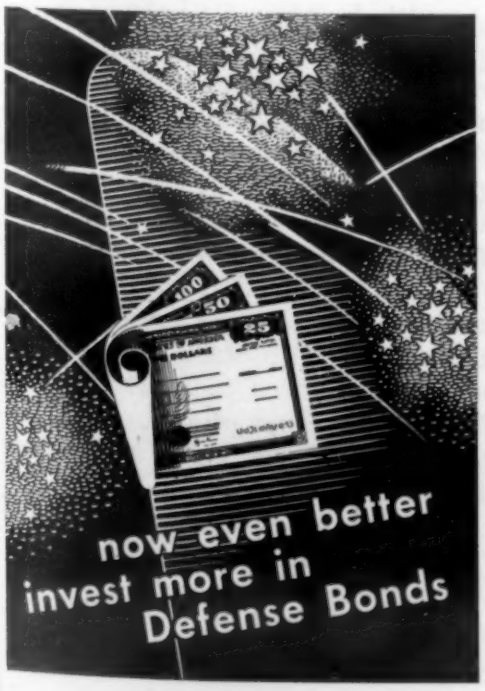
New Materials and Equipment



Industrial Coating Offers Many Advantages

A new coating developed to meet the needs of industry for a coating which would give protection against corrosion caused by atmospheric conditions, vapors, fumes, spillage and splash of chemicals, has been announced by *Flexrock Co.*, Protective Coating Div., 3604-D Filbert St., Philadelphia 4. Flexcoat maintenance coating is said to give excellent protection against corrosion caused by acids and alkalis. It can be brushed, sprayed or dipped, and can be applied over old paints. It is claimed to have good adhesion to metal, wood or concrete and is available in a wide range of colors to decorate and identify machines and pipelines.

According to the company, Flexcoat industrial coating is a coating system characterized by extreme resistance to substances that readily attract normal paints, like caustic soda and strong acids. It is a truly plastic resin finish and contains no oxidizing oils or resins. Drying entirely by solvent evaporation, no change takes place in the film as it ages to lower its inertness to corrosive products.



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continued from page 13

escape hatch frames, dive flaps, guided missile parts and airborne radar reflector screens are typical parts. Intricate and extremely accurate sand cast wave guides are being made. Surface finishes within 100 micro in. can be held throughout large castings. Tolerances of ±0.010 in. can be held on castings up to 3 ft long. Interior surfaces of wave guides are held to ±0.004 in. tolerances, with 100 micro in. finish. Large, thin-wall magnesium castings save tooling, labor and machine time. Higher rigidity is obtained than with fabricated units. Complicated integral units impossible or extremely difficult to obtain by fabrication can be cast.

Atomic Laboratory Cuts Radioactivity in Waste Gases

Waste gases as finally discharged into the air, from the Knolls Atomic Power Laboratory at Schenectady, N. Y., are no more radioactive than the normal surrounding atmosphere and, in many instances, are even less radioactive, a General Electric scientist said recently. Speaking before the Fifth Annual Conference on Instrumentation and Nucleonics in Medicine, sponsored by the American Institute of Electrical Engineers, Joseph J. Fitzgerald described how an atomic energy laboratory can operate safely in a populated area.

The laboratory is principally engaged in building a prototype atomic power plant for U. S. Navy submarines. Its research involves work with uranium 235 and other elements that release nuclear energy by the process of fission. A constant study is made of the waste gases discharged into the air, in order to afford the maximum protection of the neighborhood. These gases are discharged through a 100-ft stack, and are constantly monitored to make sure that the concentration of radioactive material is kept well below permissible limits, the G-E scientist said.

"Constant air monitors are located at selected sites to check the radioactive concentrations at various points near ground level. Plant samples also are analyzed on a regular schedule

News Digest

to evaluate the accumulation of radioactivity on vegetation," he said.

Describing the safety operations, he said that the waste radioactive gases and smokes from the working areas are first passed through a scrubber, in which a caustic solution washes out the larger radioactive particles as well as the more volatile components. Next, they go through a high-efficiency filtering system, which removes more than 99.9% of the small amount of radioactive material left. The air that remains is diluted, from a thousand to ten thousand times, with filtered air from the ventilating system of the building, and then is discharged through the stack.

Normal atmosphere contains measurable but harmless quantities of radioactive elements, and these produce radioactive particles which are also removed by the filtering process.

"As a result," he said, "in many instances the effluent from our stack is cleaner radioactively than the atmosphere itself."

Plastisol and Petroleum-Base Coatings Inhibit Corrosion of Metal Parts

Over 200 representatives of industry and Government attended a two-day forum on packaging to inhibit corrosion, sponsored by General Motors and the R. M. Hollingshead Corp. Subjects ranged from the mechanism of corrosive attack through testing and specification of coatings to protective coating materials, with the major emphasis on peelable plastics.

A new cold-dip plastics material (plastisol) was discussed and demonstrated. This material, in which a corrosion inhibitor has been incorporated, is applied by dipping at room temperature. By heating to approximately 300 F the plastisol is converted to a tough adherent solid coating. Tests indicate that after this treatment the coating is comparable to and in some respects superior to the hot-dip materials which are in current use.

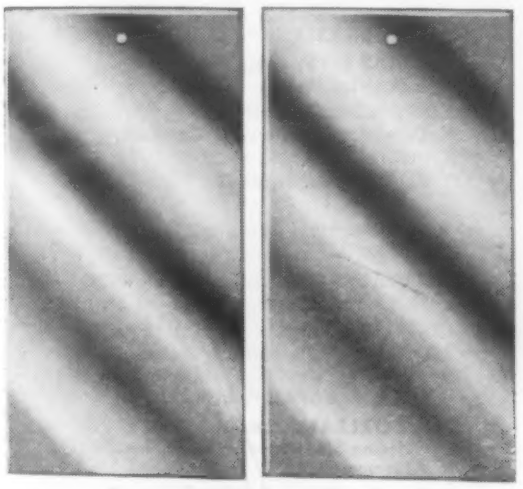
Among the petroleum-base coat-

(*Continued on page 170*)

Advertisement

Clear Lacquer Stands Salt Spray Tests for Unusual Periods

Tests conducted by an unbiased laboratory demonstrate that a transparent lacquer, already widely known for its remarkable adhesion to practically all commonly used metals, has the added advantage of exceptional durability. In these tests, the lacquer, produced by Maas & Waldstein Co. and sold under the trade name of DULAC Clear Universal Lacquer #462, was subjected to salt spray and weatherometer tests for exceptionally long periods. No sign was observed either of finish failure or of discoloration of the metal.



(Left) A zinc-coated steel panel newly coated with DULAC No. 462.
(Right) A similar panel after hundreds of hours' exposure to salt spray, showing no evidence of attack on the finish.

Typical Applications

This unusual durability of DULAC Clear Universal Lacquer #462 has led to its extensive use as a replacement for chromium or other metals normally plated of zinc or zinc-plated steel. An additional important field of application lies in the protection of chromium which because of metal shortages is being plated directly over steel, without the customary underplating of nickel-over-copper.

An air-drying coating, DULAC #462 is easily applied by dip or spray. It dries out of dust in 5 to 10 minutes, and hard in an hour. Technical Data Bulletin #110 in DULAC #462 is available from Maas & Waldstein Co., 2121 McCarter Highway, Newark 4, N. J. On request M & W Technical Service Engineers will discuss specific problems.

ADHERES
to almost any metal
INVISIBLE
on all of them
DULAC Clear Universal Lacquer #462

Here is a *single* water-white lacquer with remarkable adhesion to practically *all* metals. It's DULAC Clear Universal Lacquer #462.

Finishing shop after finishing shop* reports that this M & W lacquer can be applied with *equal* success to just about any metal—and that it's invisible when applied.

AND . . . tests conducted by an unbiased laboratory show that DULAC #462 withstands salt spray and weatherometer tests for longer periods than ordinary lacquers.

DULAC #462 forms a tough, lasting protective film that resists heat, cold, weather, stain, perspiration. It cuts down on *inventories*, because one lacquer handles so many metals. It cuts down on *production time*, because it dries out of dust in 5 to 10 minutes . . . hard in an hour. Applied by spray or dip.

*Names on request

For complete information, write for Technical Data Bulletin #110, or let our M & W technical consultant discuss your requirements privately with you.

PIONEERS IN PROTECTION

OUR 78th YEAR • M & W CO 1874

MAAS & WALDSTEIN CO.

MANUFACTURERS OF INDUSTRIAL FINISHES

This soot blower element has been coated with high-temperature ceramics to extend its life in the corrosive service it will encounter in a water tube boiler.

High Temperature Ceramic Coatings in Industrial Applications

by D. K. Krosch, Superintendent, Solarmic Dept., Solar Aircraft Co.

They are prolonging life of heat treating fixtures, furnace parts, and equipment in processing industries.

● AS HIGH TEMPERATURE operations find wider use in industry, high temperature ceramic coatings are being used increasingly to lengthen the service life of metal parts subjected to intense heat.

Already high temperature coatings, such as the Solaramic series developed by Solar Aircraft Co., have found a definite and important niche in military production. At the same time, peacetime industries in a variety of fields are studying the use of ceramic coatings in their everyday operations.

(*Continued on page 164*)

You file his name under Service

GOOD reason for keeping in close touch with your Kaiser Aluminum Distributor is the *extra service* he makes available to you.

He gives your order personal attention, whether the market is soft or tight, the job large or small. He learns your problems, suggests solutions based on his specialized knowledge and experience handling countless problems *like* yours.

He investigates new methods to help you get more from available supplies. For experimental work, and for emergencies, he helps you obtain supplies. Often he assists you in securing subcontracts by keeping you posted on continually changing government requirements.

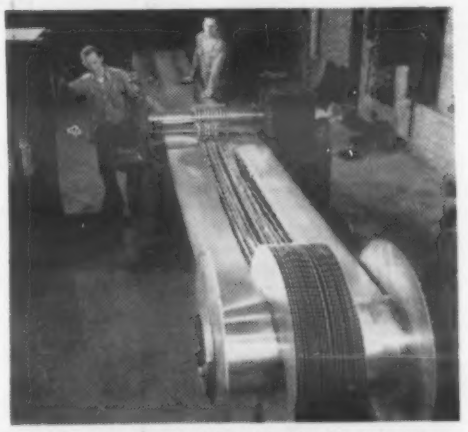
Even now, he may be able to supply all the aluminum you need. For Kaiser Aluminum will soon have increased its production of primary aluminum 137%.

See your Kaiser Aluminum Distributor *soon*.

HERE'S HOW YOUR DISTRIBUTOR HELPS YOU:

MORE VERSATILE INVENTORY—Large stocks maintained by your warehouse distributor give you the opportunity to select from a complete range of alloys and form.

LOWER COSTS—Specialization of warehouse plant and handling equipment permits deliveries at lower cost at machine side, cuts stock keeping and accounting costs.



LOWER RAW MATERIAL INVESTMENT—Slit, sheared, or sawed stocks to fit every production demand can be delivered to you daily. Eliminates expense of idle or obsolete inventory.

SMALLER SPACE REQUIREMENTS—Small lot purchases mean less space is needed to house raw materials. Result: you can devote more space to profitable production.

Kaiser Aluminum

Setting the pace . . . in growth, quality and service

PRODUCERS OF: Sheet • Coil • Plate • Pig • Ingot • Billet • Foil • Electrical Conductor Residential Siding • Corrugated Farm and Industrial Roofing • Shade Screening • Rod, Wire & Bar Screw Machine Stock • Forging Stock • Rivet Wire • Roll-Formed Shapes • Extrusions

Hi-Temp Ceramic Coatings

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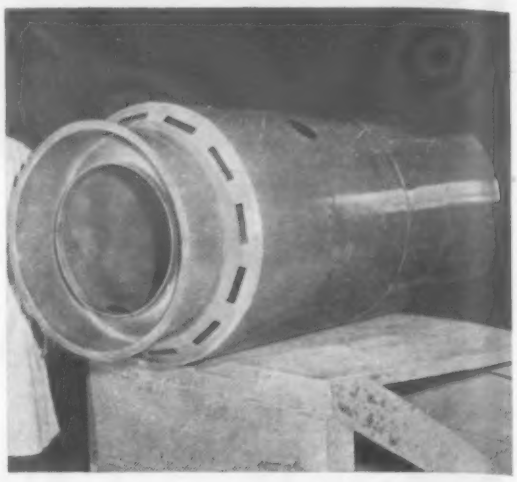

Made of Type 309 stainless steel, this burner unit for oil refining equipment has been coated with ceramics and is now under tests. Its life is expected to be double the service life of the uncoated chamber.

Heat Treating Equipment

Heat treating and other industrial furnace applications are common in many industries. Recently, at Solar, we experimentally coated a number of furnace jigs and fixtures. The results were excellent. Fixture life was extended four to five times. If care is taken to recoat the fixtures and jigs at required intervals, life of the parts can be extended almost indefinitely.

Now Solar is ceramic-coating all furnace fixtures and firing jigs used in the firing of ceramic coated parts, which is done usually at temperatures varying from 1600 to 1900 F. Solar is also coating the jigs and fixtures used in other types of furnaces for heat treating in the company's plants. And, in new conveyorized furnace facilities now being built, all parts subjected to heat will be coated, including the conveyor shoe plates and hooks.

Longer life for jigs and fixtures is not the only advantage of ceramic coating. Scale is prevented, so a scale-free furnace operation is possible. In Solar's furnaces, most jigs and fixtures are made of Type 321 stainless; some are cast of Type 330, and some are made of Incoloy. Coatings on these alloys have tremendously increased their useful furnace life.

In industrial furnaces themselves, any metal parts required to withstand excessive heat can be ceramic coated profitably, including burner tips. Coatings will not only yield savings through longer life for metal parts, but will also reduce unprofit-

(*Continued on page 166*)

what's cookin' in production economy?

The separator strip for the oven door window is made of Nickeloid Chrome Steel . . . a highly successful application.

Broiler grid . . . durable, easy-to-keep-clean, heat-resisting . . . formed from pre-plated Nickeloid Chrome Steel or Chrome Aluminum.

This splash back — modern yet functional — is formed from Chrome Steel — will not peel or blister.

The oven vent uses a pre-plated metal by Nickeloid. No plating or polishing is required after fabrication and installation.

Stove door handles . . . another perfect application of Nickeloid Metals as used on many well-known makes of ranges.

product beauty is more than skin deep

The stove industry is just one of many that has made wide and successful use of Nickeloid Metals.  Manufacturers of ranges and appliances have found that appearance is improved, manufacturing costs, reduced, with this **finished** raw material  Chrome Steel, as shown in the illustrations of stove parts on this page, serves a functional purpose as well as providing attractive, durable trim.  Are YOU taking advantage of this modern method in the design and manufacture of **your** product? It will pay you to investigate.

AMERICAN NICKELOID COMPANY
Peru 6, Illinois

pre-plated metals for industry

NICKELOID METALS (Pre-Plated)
NICKEL · CHROMIUM · BRASS · COPPER
Electro-plated TO ALL COMMON *Base* METALS
ALSO LACQUERED COLORS
SHEETS AND COILS
OLDEST AND LARGEST PRODUCERS OF PRE-PLATED METALS

Hi-Temp Ceramic Coatings

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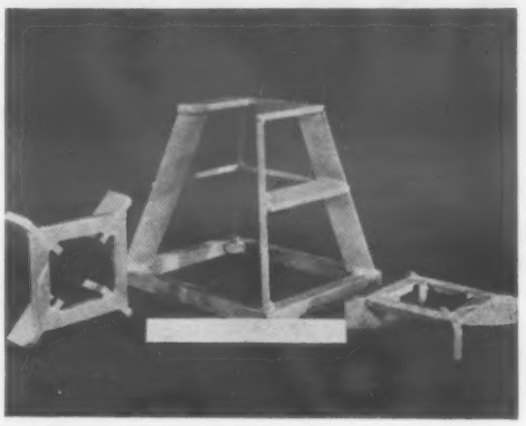

These heat treating jigs, cast of Type 330 stainless, are coated with high temperature ceramics to increase their service life.

able shut-down while parts are being replaced.

In another application, a manufacturer of gears has tested ceramic coated stainless steel carburizing racks. Both coated and uncoated racks were run through about 50 carburizing heats. During each heat they were at 1680 F for 7 hr, and at an average temperature of 1550 F for about 4 hr. They were then directly quenched from 1550 F in oil with medium agitation. At the end of the tests, the coated racks were not only in better condition, but were in as good condition as when they had been received. It was also noted that distortion in the coated racks was less than in the uncoated ones.

Other Uses

Outside of firing and heat treating, numerous other industrial uses of ceramic coatings are under study. It is believed that in many hot air or hot water systems, where metal is destroyed by combined heat and corrosive action, coatings would be of value. And tests are being made to find the value of coatings as protection against the corrosive effects of mild acids and alkalies in chemical processing and similar applications. Results are highly promising.

Research men feel that the field for ceramic coatings in industry has barely been scratched. In an experiment with industrial pumps, for example, it was found that ceramic coating not only reduced corrosion, but also increased the wear resistance of the parts and resulted in an increase in pump efficiency of 7 to 9%.

Both heat and corrosive liquids and gages are encountered regularly in such industries as chemical processing, petroleum refining, food proc-

(*Continued on page 168*)

Hi-Temp Ceramic Coatings

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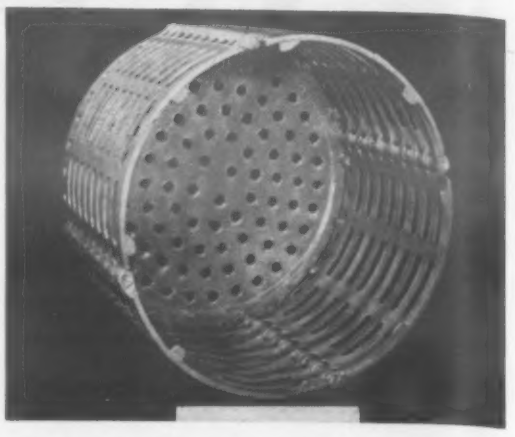

A heat treat basket, made of Type 330 stainless, is ceramic coated in order to protect it from oxidation in high temperature service.

essing, and many types of metalworking. Ceramic coatings may be an answer to the expense and scarcity of super alloys, providing longer service life and decreasing maintenance costs.

Since ceramic coatings in industrial uses are comparatively new, little long term test data have been accumulated. One of the early ceramic coating jobs by Solar, however, provides a dramatic example of the potential benefits of coating. In this case, some burner tubes used in an industrial heating unit were subjected to a field test by the customer. The tubes were fabricated of Inconel; one was ceramic coated, the other uncoated. They were operated at about 2000 F. After 136 hr of operation, the uncoated tube was completely corroded and eroded. But after 566 hr of operation, the ceramic coated tube was still in serviceable condition.

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● Stock lines in food, paper, and chemical plants; heat exchanger units in processing industries; cooling coils in breweries, beverage industry, dairies and dairy equipment...throughout all industry, wherever there's a stainless or high alloy tubing application, there you'll find TRENTWELD.

And it's to be expected! TRENTWELD is made in a tube mill by tube engineers who roll and weld stainless and high alloy tubing exclusively. Then too, TRENTWELD is available in a full range of sizes — $\frac{1}{8}$" to 36" in diameter. This, coupled with Trent's convenient mid-continent location, means prompt delivery of what you want ...when you want it. If yours is a stainless or high alloy tubing requirement: Call on us.

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN

(Subsidiary of Crucible Steel Company of America)

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continued from page 160

ings discussed were polar compounds and thixotropic compounds for use in the protection of highly polished parts during storage. The status of a number of Government specifications dealing with compounds of this type was discussed by representatives of the Defense Dept.

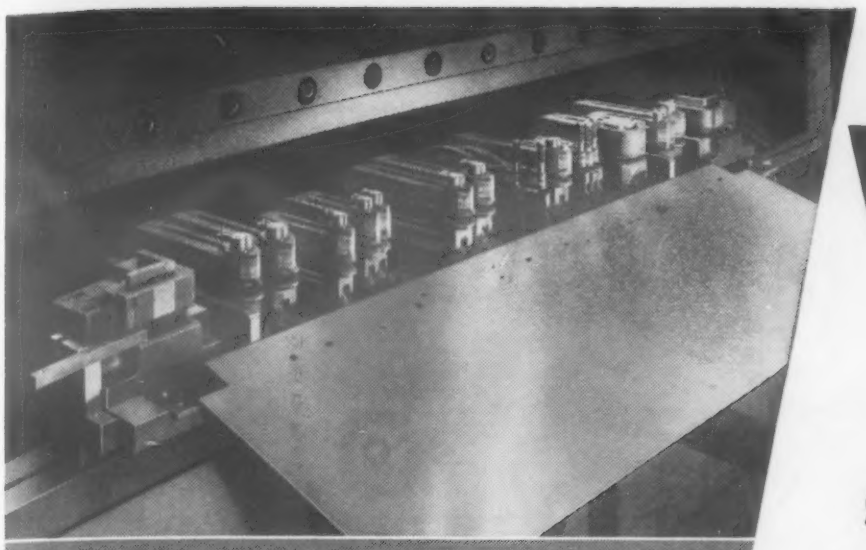
Westinghouse Engineer Describes Materials Engineering

Although each operating division of Westinghouse has its own materials engineers, who not only test the materials bought and used by their division, but also develop new materials specifically for the use of their own plants, much of the development of materials is done by a central organization, the Materials Division, according to J. B. Seastone.

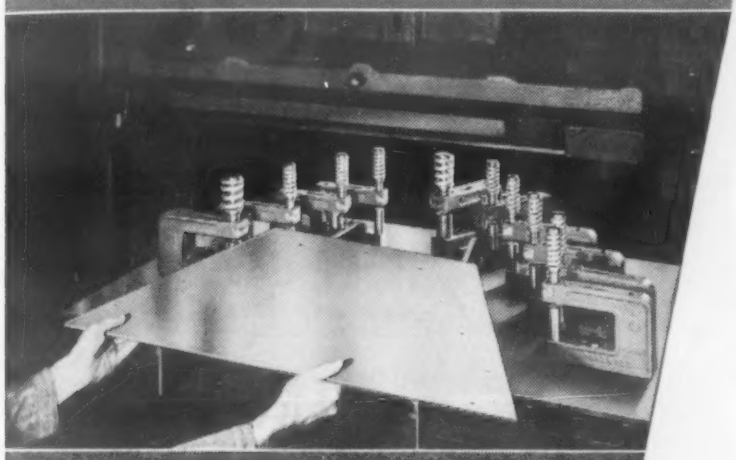
In a paper given at the Trends in Electric Power in Industry Conference in Pittsburgh recently, Mr. Seastone, manager of Materials Div., Westinghouse Electric Corp., said that the situation of the electrical industry with respect to materials has been unique. While physical properties—tensile strength, hardness, resistance to the elements—are of primary importance to most manufacturers, the electrical manufacturer has another complete set of supplementary requirements—electrical characteristics. Reduced to its simplest terms, this has meant that the electrical industry has, to a large degree, had to develop its own materials.

Stove iron, paper, silk and shellac were the materials of the electrical industry in its infancy. They were the only materials available. Neither manufacturers nor suppliers then realized the tremendous importance that materials were to play in the industry's development. Today, the electrical industry uses a whole host of special materials, plus sizable quantities of more standard materials. Some were developed for their magnetic or electrical properties.

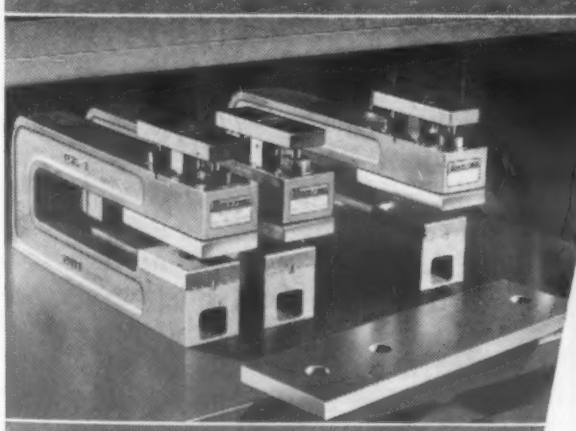
Materials Engineering maintains and operates a full complement of physical and chemical testing laboratories, in which it tests most of the thousands of kinds of materials used by the company. But the major activity of the department is in the



Showing Wales Type "BL" Hole Punching and Type "N" Notching Units in a combination press brake setup for punching and notching mild steel up to 1/8" THICK.



A stamping press setup of Wales Type "CJ" Hole Punching Units for punching mild steel up to 1/4" THICK.



Showing a setup of Wales Type "HS" Hole Punching Units in a press brake for punching mild steel up to 3/4" THICK.

Showing a setup of Wales Type "NJ" Notching Units in a stamping press for notching mild steel up to 1/4" THICK.

PUNCHING 1/8", 1/4" AND 3/4" THICK METAL ?

standardize on WALES Hole Punching Units

Only Wales Hole Punching and Notching Units provide the numerous *patented features* plus the *time and cost saving advantages* that have made it "standard practice" with thousands of metal fabricators to *standardize* on this *exclusive* equipment.

Wales independent, self-contained Units eliminate costly, single-purpose custom dies, reduce expensive setup time and practically eliminate press "downtime."

The same group of Wales Units may be interchangeably set up in stamping presses and press brakes. In many cases, setups of Wales Units are in production the same day a hole punching pattern is released by your engineering department.

The multiple advantages of Wales Hole Punching and Notching Equipment are too MANY to tell here, so write for fully-illustrated, functionally colored catalogs TODAY.

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George F. Wales, *Chairman*

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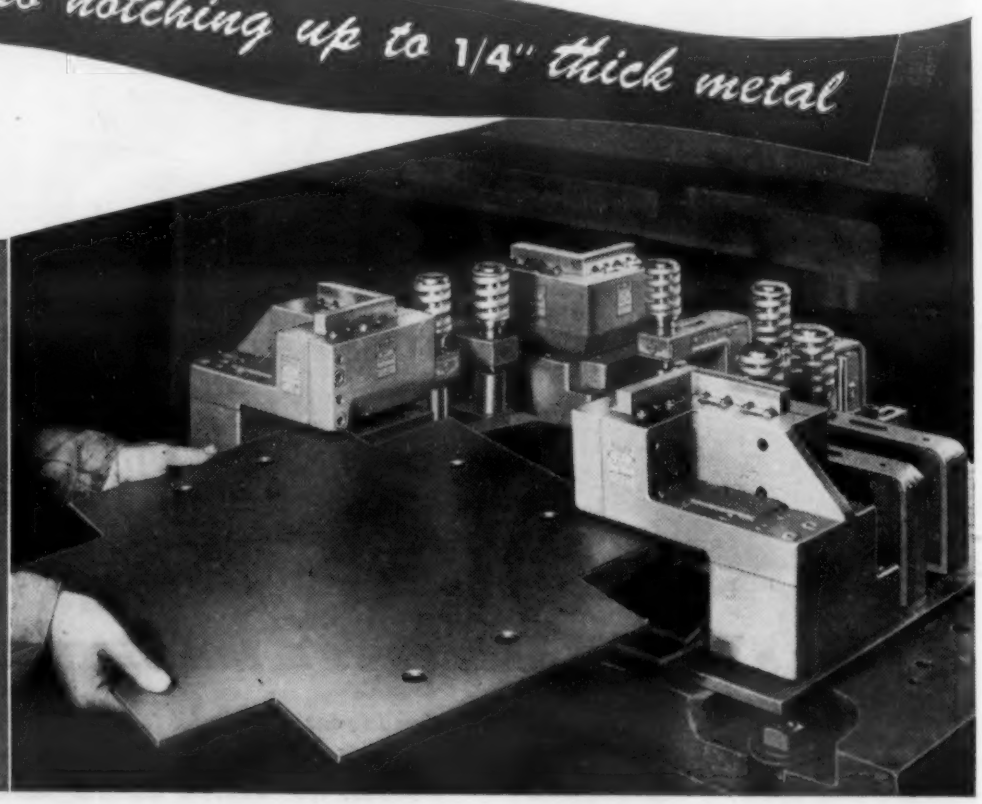
Wales-Strippit of Canada, Ltd., Hamilton, Ontario

Specialists in Punching and Notching Equipment

also notching up to 1/4" thick metal



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development and application of new materials. The basic idea often originates in the Research Laboratories. Then Materials Engineering takes over. Laboratory investigations are made, manufacturing techniques are studied, methods of fabrication planned, standard procedures worked out, and, finally—in many cases—a pilot-plant operation established. The products of this pilot manufacture are sold to operating divisions, and in some cases to outside manufacturers, before the process is finally transferred to the appropriate division.

Solubility Limit of Carbon in Austenitic Stainless Steel Studied

Austenitic stainless steels, which are characterized by a distinctive crystal structure, are widely used because they combine superior resistance to corrosion with ease of working. Properties and applications of these steels are considerably affected by the amount and form of carbon they contain. Many experimental studies have been made of various properties of these steels; but surprisingly little attention appears to have been given to the determination of the limit of solubility of carbon in one of the most widely used forms of stainless steel, chromium-nickel austenite.

Because of the importance of such knowledge, the National Bureau of Standards recently made a study of the solubility of carbon in austenitic stainless steel containing 18% of chromium and 10% of nickel. These levels of chromium and nickel were chosen as representative of the AISI types 302 and 304 stainless steels. Sponsored by the Navy Bureau of Aeronautics, the investigation was conducted by Samuel J. Rosenberg and Carolyn R. Irish of the NBS metallurgy laboratories.

The Bureau investigators found that with a carbon content of 0.007%, the lowest content studied, solution was substantially complete between 1300 and 1400 F. Solubility appeared to increase approximately linearly from about 1400 to 1975 F, the maximum temperature studied, where carbon solubility was approximately 0.08%. These values of

Accumet Precision Castings

for all industrial uses

With Accumet Precision Castings, Crucible has developed a process of producing precision investment castings in intricate designs with the smooth, satiny finish and closely-held dimensions characteristic of "lost wax" castings. Casting tolerances start at plus or minus 0.005" although under certain circumstances closer tolerances can be held. This relatively new metal forming process solves many difficult problems in design, tooling and production of metal components.

fuel injectors from precision castings

Fuel injectors and carburetors for aircraft are mechanisms containing a variety of peculiarly shaped component parts. The usual procedure is to use hardenable, chrome stainless steels, Types 416 and 440F, which are most adaptable to easy machining. However, to save costs in machining from bars, stocks and forgings, Crucible applied Accumet Precision Castings. The close size control and good surface finish of the castings eliminate many costly machining operations — saving manpower, machine time and tooling expense.

more information available on castings

Long a leader in the development of precision investment castings, Crucible offers you the services of an alert metallurgical staff to help you profitably apply these specialty steels to your operation. Write us for more detailed information. CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, P. O. Box 88, Pittsburgh 30, Pennsylvania.

CRUCIBLE first name in special purpose steels

52 *years of Fine steelmaking* **PRECISION CASTINGS**

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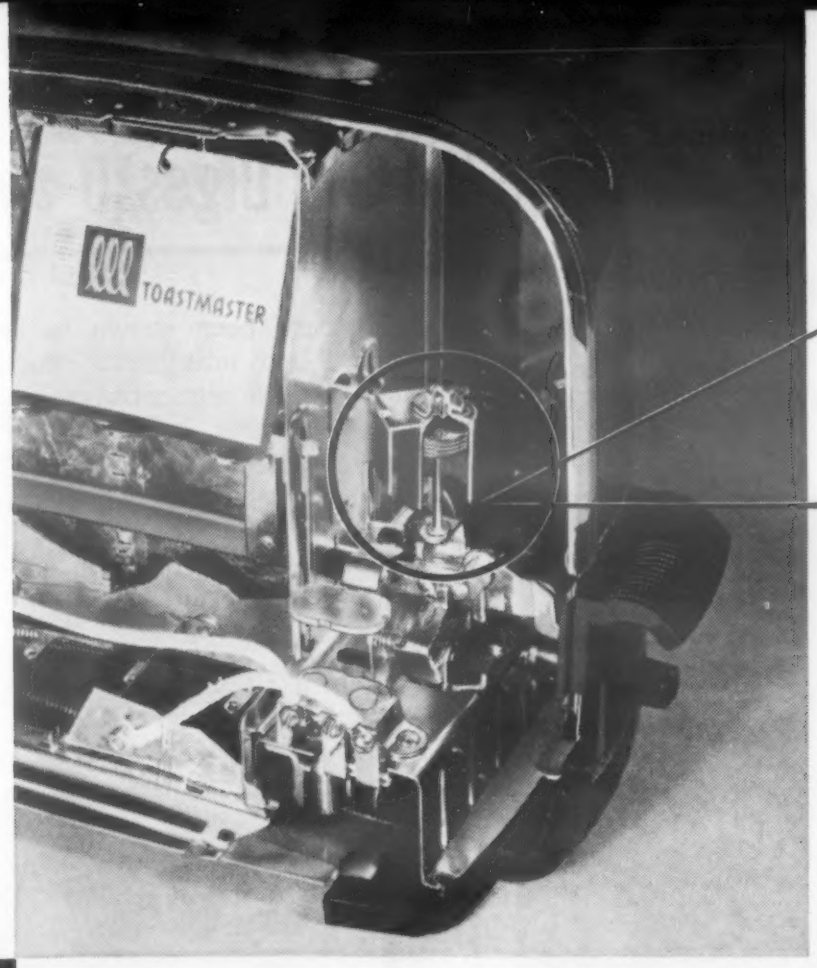
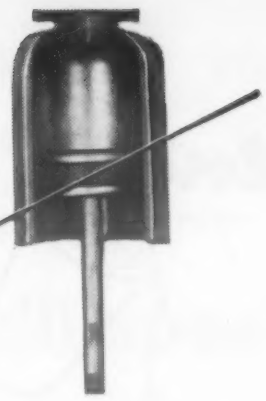
solubility are appreciably lower than those previously reported. The solubility curve developed at NBS indicates that type 304 ELC (extra low carbon) stainless steel can be effectively annealed at 1700 F, but that ordinary type 304 stainless should be annealed at temperatures in excess of 1900 F if the carbon is to be fully dissolved. The study also points up limitations on the effectiveness of attempts to eliminate intergranular embrittlement of austenitic 18 chromium-10% nickel steel by reducing carbon content.

The annealing of austenitic stainless steels is often governed by the desire to obtain a completely austenitic structure—that is a structure in which all carbon is in solution in gamma iron. To attain this end, annealing temperatures used in commercial practice are quite high, usually about 1950 to 2000 F. From another standpoint, however, such high annealing temperatures are undesirable; annealing at lower temperatures results in smaller grain size, which is thought to reduce susceptibility to intergranular embrittlement. Since the temperature at which all carbon is in solution increases with carbon content, it seems to follow that low-carbon steels can be annealed at lower temperatures than the higher-carbon varieties. In the absence of definite knowledge of the carbon solubility, however, it has been necessary to keep annealing temperatures quite high in order to assure an austenitic structure. For these reasons the results of the NBS study have considerable practical as well as theoretical interest.

The use of type 304 ELC steels in industry is based on the premise that the low carbon content (0.03% maximum) will give some protection against intergranular embrittlement. Such embrittlement results when austenitic stainless steels are subjected to temperatures in the range of about 800 to 1400 F and are either simultaneously or subsequently exposed to the action of certain corrodents. Intergranular embrittlement has been ascribed to the precipitation of chromium carbide at the grain boundaries of the austenite, and it has been proposed that the phenomenon might be completely inhibited by reducing the carbon content to less than the limit of solubility at temperatures to which the steel will be subjected. Although these extra-low-carbon





Restrictions on brass forced engineers in the Toastmaster Products Division of McGraw Electric Company to find substitute materials for a pneumatic damping device on the toast ejector mechanism. They had been using a cylinder, machined from solid ¾ inch brass rod, and a precision ground brass piston with a connecting rod on a swivel joint. The cylinder head was fitted with a spring and ball check valve. Tolerances on this complicated assembly had to be held within 2 mils to give satisfactory performance for at least 100,000 cycles at 350° F.

On pneumatic dampers

SILASTIC* simplifies design

. . . saves critical materials

Many substitute materials and designs were tried with disappointing results before one of our technical representatives dropped in with samples of Silastic. Using this heat-stable, rubbery silicone product, Toastmaster's research and development engineers perfected a very simple and durable damper. It consists of an inexpensive drawn steel cylinder, a 1-piece connecting rod, and a flat ring-shaped Silastic piston mounted loosely between two metal cup washers with a simple air leak past the shoulder of the piston.

Tolerances on the new damper are large; the cylinder can be out of round; 86 pounds of mild steel displace 199 pounds of brass per 1000 toasters. *And the new device works better than the more expensive brass assembly.* Such performance proves the usefulness of Silastic as a new engineering material. It retains its rubbery properties and its good dielectric properties at temperatures ranging from below —70 to above 500° F. It is highly water repellent; shows excellent resistance to weathering and to a variety of hot oils and chemicals.

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MIDLAND, MICHIGAN
In Canada:
Fiberglas Canada Ltd., Toronto
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Midland Silicones Ltd., London

News Digest

steels have been shown to be less susceptible to intergranular embrittlement than the higher carbon varieties, the NBS study indicates that it is impracticable, if not impossible, to produce steels with carbon contents sufficiently low to insure freedom from carbide precipitation under all conditions of service.

Extreme Temperature Chamber Aids Testing at Northrop Aircraft

Northrop Aircraft, Inc. has installed a new high-performance extreme temperature chamber in its engineering laboratories for testing components of Scorpion F-89D all-weather interceptors and guided missiles.

Air temperature in the chamber can be lowered from 70 to-85 F in 10 min and raised from 70 to 180 F in 7 min, with the chamber designed for operation at any temperature between —100 and +250 F.

The unit was designed in accordance with Northrop specifications by the Industrial Refrigeration Co. of California, in Los Angeles, and was installed by Northrop to comply with stepped up U. S. Air Force specifications for high and low temperature testing of components for jet aircraft and guided missiles.

Low temperatures are obtained by a dry ice-methanol system used in the industry for this type of work. Dry ice is used to cool methanol in a sublimation tank, and the solution is then pumped through the tubes of a finned tube heat exchanger. A fan circulates air from the test chamber through the fins of the heat ex-

(*Continued on page 179*)

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changer and cools the air. An unusual feature of the unit is that it is equipped with auxiliary devices for cooling the methanol with liquid instead of solid carbon dioxide. Use of this system eliminates many of the disadvantages of dry ice operation such as storage losses, handling and contamination of the methanol.

Heating the chamber is accomplished by circulating air through a group of finned type electric heaters.

The temperature controller is an air-operated proportional-automatic reset type using copper-constantan thermocouples. Low temperature control is accomplished by modulation of air-operated flow control valves in the methanol system. For high temperature control, the controller imposes proportional-reset action on a pneumatic interrupter, which, in turn, controls the electrical input to the heaters on a time cycle basis. The control range of the unit is further enhanced by the use of a multi-speed motor on the air circulating fan. The control thermocouple circuit is connected through a selector switch to four of the thermocouple terminals provided inside the chamber. The remaining ten thermocouple terminals are connected through a selector switch to a second recorded in the controller, which can be used to record temperatures of specimens being tested in the chamber.

The test chamber and sublimation tank, together with all operating and control components and accessories, are integrally mounted on a steel base equipped with casters. This feature increases the utility factor of the unit in that it can be moved to the site of other existing facilities that may be required for a particular test, thus avoiding unnecessary duplication and decreasing test setup time.

The fast rate of temperature change available in the unit makes possible the performance of several repeat tests in a single day.

International Magnesium Exposition to Be Held Next March

Plans for the first International Magnesium Exposition were announced at the annual meeting of the Magnesium Association in New York City. The announcement was made by

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A. W. Winston, president of the Association.

The Exposition will be held Mar. 31, Apr. 1 and 2, 1953, in the Washington National Guard Armory in Washington, D. C., under the sponsorship of the Magnesium Association. It will be open to the public.

"The first International Magnesium Exposition will provide the greatest concentration of magnesium know-how, demonstrations and exhibits ever housed in one location," stated Winston. "It will demonstrate the extent to which the lightest of all structural metals, magnesium, is being utilized for both civilian and military purposes.

"The primary purpose of the Exposition is educational. Through live exhibits of magnesium production processes and product displays of both military and civilian applications, the Exposition will demonstrate that magnesium is a structural metal governed by the same principles of design, fabrication and production as are steel, aluminum, copper and wood."

Winston said the Association has appointed a six-man committee to plan and execute arrangements for the Exposition. It consists of C. H. Corey, chairman, Brooks and Perkins, Inc.; D. E. Harvey, Magnesium Co. of American; R. L. Hoy, Aluminum Co. of American; G. F. Ihrig, Wellman Bronze and Aluminum Co.; J. B. Weil, Magnesium Co. of America; and J. V. Winkler, Dow Chemical Co.

Plan Big Market Expansion for Large Plastic Moldings

Plans for stepping up the already widespread use of large plastic moldings in the home appliance and furniture fields were announced recently by 12 leading companies in the plastics field at a meeting in New York. Representatives of the 12 major companies have formed a special committee—the Big-Unit Thermosetting Molders Committee of the Society of the Plastics Industry—which plans to lay the groundwork for a campaign to acquaint the public, manufacturers, industrial designers and interior decorators with the advantages of engineered moldings.

A prediction was advanced by the gathering that a plastic molding

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would provide the ideal furniture drawer—one piece, non-warping, non-sagging, and light in weight. Other applications suggested were desk and chair bases, night tables and other similar large furniture units. These items can be produced from phenolic, urea or melamine molding compounds. The last two for the first time are available in the 29 colors adopted by large numbers of paint, furniture, radio and television, appliance, textile and floor covering manufacturers. This color system will permit blending of plastic units with modern living room decor.

News of Engineers

Louis Moses, mill engineer, Bethlehem Steel Corp., has been judged winner of the $300 first prize in the 1951 Kelly Award Competition sponsored by the Association of Iron and Steel Engineers. His paper, "A Report of Rolling Experiences," was written while Mr. Moses was superintendent of the Rail Mill and Toll Dept., Bethlehem Steel Co. Second prize of $200 was awarded to *F. H. Wickline,* electrical engineer, National Tube Div., U. S. Steel Co. *John R. Chegwidden,* assistant superintendent of the Saucon Div., Bethlehem Steel, was awarded third prize of $100 for his paper.

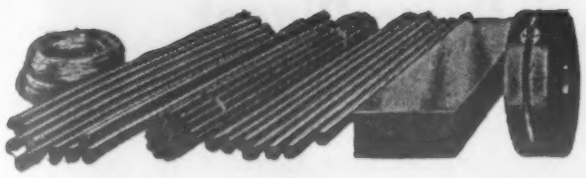
Three promotions and one retirement have been announced by Norton Co. *George H. Powers* has been appointed refractories engineer, replacing *Fred E. Lieby,* who has retired; *Lincoln M. Johnson* was named honing engineer; *Enfried T. Larson,* formerly sales engineer, was appointed editor of technical publications.

A. Donald Kelso, executive vice president and director of Norton Behr-Manning Overseas Inc., has become president of the company, succeeding *Herbert A. Stanton,* who is retiring.

Appointment of *Neil L. Anderson* as manager of the Steelstrap Dept., Acme Steel Products Div., Acme Steel Co. has been announced. Other appointments include that of *Whitford A. Baldwin* as manager of the Unit-Load Dept., Acme Steel Products Div., and of *Harry R. Sanow* as general superintendent of Acme Steel Co.'s Riverdale Works, Riverdale, Ill.

Rex W. McMillan, formerly in charge of technical sales problems at the Milford, N. H., plant of Hitchiner Manufacturing Co.'s precision investment castings, has been transferred to the W. Hartford, Conn., sales office.

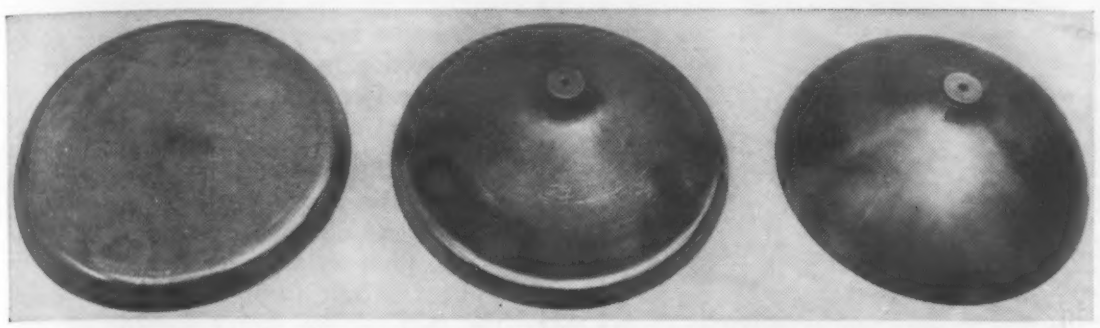
A. C. Gunsaulus, manager of development activities for the Wheel and Brake



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" BRASS — MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Three stages in the manufacture of an electric light reflector from brass by the spinning process. Courtesy Lehrolite Inc., Wallingford, Connecticut.

Spinning Brass and Copper

Spinning is a method for making hollow shapes from sheet metal discs by pressing a tool against the rotating metal which is backed up by a spinning chuck of the desired shape. It is economical for small production lots only, because the initial outlay for tools and equipment is small.

However, this fairly ancient process is still used for the manufacture of "hand-made" items in limited quantities such as electric lighting fixtures and table lamps; vases, gift items, parts for candlesticks, frying pans, pots, special parts for electronic devices, etc.

Variety of Metals

Spinning is not limited as to size of the part or kind of metal. All wrought metals can be spun provided adequate power is available to exert sufficient pressure to make the metal flow to the desired shape.

To attain a deep or intricate shape, spinning is done in stages using different shaped chucks for each operation.

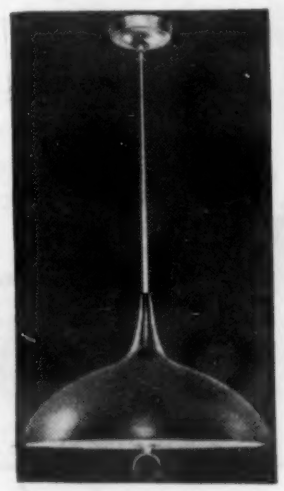
Grain Size Important

For a smooth finish, the annealed brass sheet should generally have a medium fine grain size, say .040 to .050 millimeter on metal between .020 to .045" in thickness. On heavier gauges, a larger grain size may be required for easier spinning. However, since most jobs call for annealing or softening at intermediate stages, which is necessarily performed by the fabricator, he should take care not to over-anneal the metal so as to produce a coarse grain structure. After spinning this may result in a rough, grainy (orange peel) surface which requires unnecessarily long polishing for a satisfactory finish. A corresponding increase in cost follows.

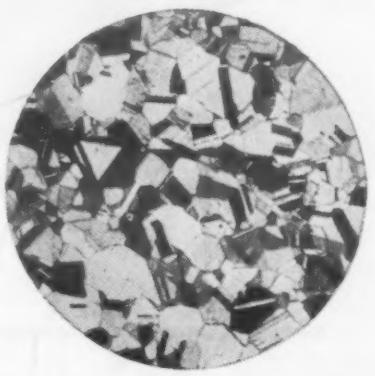
Many operators anneal parts with a gas-fired torch. This is not economical, uniform, or satisfactory for commercial runs because it is difficult to control the anneal or grain size. A pyrometrically controlled annealing furnace is more desirable.

Danger From Stress Corrosion Cracking

In making large parts like brass lighting fixture reflectors, illustrated above, the metal is annealed after the second spinning operation, when the shape is practically completed. The final spinning does not stress the metal excessively and danger from stress corrosion cracking is remote. When small, deep parts like flanges are spun without any intermediate annealing operation, excessive stresses may be developed. This may lead to stress corrosion cracking provided other conditions also exist such as the presence of moist ammonia, even in traces so slight that it cannot be detected by the sense of smell; air or oxygen; and the element of time. This combination of conditions may easily take place outdoors, or when poor conditions of storage generate ammonia from decomposed products containing nitrogen. Residues from cyanide cleaning solutions on the metal surface and dampness may decompose to form ammonia.



Decorative pierced metal lighting fixture made from brass or copper. Courtesy Lehrolite Inc., Wallingford, Connecticut.



70-30 brass annealed. .045 mm. Grain size. Mag.75x

Preventing Stress Corrosion Cracking

Stress corrosion cracking can be prevented by relieving excessive stresses by heat treatment. A special type of furnace is required where the gases are

blown on the work and the heat is transferred by conduction rather than by radiation. Heat treatment at a temperature between 520°F to 575°F for about a half hour or longer, depending upon the load, will relieve stresses with no appreciable softening of the brass.

Copper and high-copper brasses, silicon bronze, and cupro nickel are considerably less susceptible to stress corrosion than yellow brass and generally do not require stress relief heat treatment. Our Metallurgical Laboratory will be glad to help customers that are experiencing trouble from stress corrosion cracking or other metal problems encountered in the fabrication of metal goods. Write for Bridgeport Brass "Technical Handbook" (168 pages) on company stationery. (9066)

News Digest

Div., Goodyear Aircraft Corp., and *W. C. Johnson, Jr.,* research and development engineer, have been elected to important posts in the Northern Ohio Chapter of the Society for Experimental Stress Analysis. *Harry Slanta,* a former member of the company's Tooling Div., and for the past seven years a machine designer at the Goodyear Tire & Rubber Co., has returned to Goodyear Aircraft as assistant manager of the Tool Engineering Div. In another major change, *Paul R. Herholz,* section head in the Production Engineering Dept., has been named manager of the tool engineering staff department.

P. R. Mallory & Co., Inc. has announced the appointment of *Victor Welge* as associate director of engineering. Mr. Welge formerly served with Consolidated Vultee Aircraft Corp., where he headed the staff of the firm's Electronics and Missile Section.

Foote Mineral Co. has announced the addition of *Charles P. Miller,* junior mineralogist, to its Research and Development Dept.

Charles D. Greentree has been appointed manager of engineering of General Electric Co.'s General Engineering Laboratory. Mr. Greentree, formerly manager of the laboratory's Development Manufacturing and Plant Services, succeeds Dr. *Martin A. Edwards,* whose appointment as manager of engineering of the company's X-Ray Dept., has been announced. *Dagfin H. Hanson* will succeed Mr. Greentree.

Appointment of *John L. Myers* as products engineering manager in charge of design, manufacture and inspection has been announced by National Electric Products Corp.

Kenneth A. Earhart has been named to the newley created post of manufacturing manager, Coating Resins Dept., Plaskon Div., Libbey-Owens-Ford Glass Co. Mr. Earhart joins Plaskon after 13 years with the U. S. Industrial Chemicals Co., where he was director of resin research and assistant coordinator of resin technical development.

American Brake Shoe Co. has announced the election of *Kempton Dunn* as first vice president, *William B. Jordan* as treasurer and *Robert Watts* and *Owen B. Cottle* as assistant treasurers.

Pastushin Aviation Corp. has appointed *Harold Helbock* as production manager.

Norry W. Hastings has been named chief chemist for Rezolin, Inc., according to a recent company announcement.

Francis O. Case, vice president of Anaconda Copper Mining Co., has been made president of the company's newly organized subsidiary, Anaconda Aluminum Co. (formerly Harvey Machine Co., Inc.).

The appointment of *Robert W. Holman* as assistant general superintendent of the Gary Sheet and Tin Mill, U. S. Steel Co.

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has been announced. *Charles M. Shank* will succeed Mr. Holman as division superintendent of maintenance and utilities.

In line with the R. M. Hollingshead Corp.'s current expansion and reorganization of its executive staff, *A. E. Moore, V. M. Mantz* and Dr. *V. Esposito* have been appointed to new positions in the firm's Research and Development Div. A. E. Moore has been appointed vice president and director of research and development; Mr. Mantz has been named director of government and industrial research; Dr. Esposito has become director of new products development.

T. E. Schroeder has been named chief engineer of the Heavy Furnace Div., Sargeant & Wilbur, Inc.

David A. Thomas has been appointed executive vice president and general manager of Automatic Steel Products, Inc.

According to a recent announcement, the California Div. plant of H. Kramer & Co., recently opened, will be under the direction of *Alvin A. Meyrowitz,* vice president and general manager.

Two new general manager posts have been created within Continental Can Co.'s Eastern (Metal) Div. Under the new setup, *Lenvik Ylvisaker* will be general manager of the Northeastern district, and *Wilbur K. Neuman* will be general manager of the Southeastern district.

S. W. Farnsworth, president of the Torrington Manufacturing Co., has announced the election of *Andrew Gagarin* to the presidency of the company, effective Jan. 1, 1952, when Mr. Farnsworth will become chairman of the board. Mr. Gagarin is currently vice president of the company.

L. Irving Woolson, vice president in charge of manufacturing and a member of the board of the DeSoto Motor Corp., a subsidiary of Chrysler Corp., has been elected president of DeSoto to succeed *C. E. Bleicher,* who died recently.

Richard P. Seelig, formerly a vice president of American Electro Metal Corp., has recently been named executive vice president of Chromalloy Corp.

Appointment of *Gordon C. Knight* as assistant to the president of International Telephone and Telegraph Corp. has been announced.

George W. Roper has been promoted to the position of assistant technical director of the Dust and Fume Control Div. at American Wheelabrator & Equipment Corp.

Dr. *Robert B. Dean,* former assistant professor of chemistry and director of chemical research at the University of Oregon, has joined the Borden Co.'s Chemical Div. as chief analytical chemist.

Several promotions have been an-

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nounced by Snyder Tool & Engineering Co. and its subsidiary, Arthur Colton Co. *Bruce M. Regan* has been made manufacturing manager of all Snyder and Colton plants; *George Derwich* has been named plant superintendent of Plants No. 1 and No. 2; and *Robert J. Maxvill* succeeds Mr. Derwich as assistant plant superintendent.

The 1952 recipients of medals of The Franklin Institute have been announced. Among those mentioned are: *Albert J. Williams, Jr.,* associate director of research for Leeds and Northrup Co., who received the John Price Wetherill Medal for his invention of the Speedomax self-balancing recorder; for their achievement in the discovery of a new process for manufacturing glass, *Harrison P. Hood* and Dr. *Martin E. Nordberg,* research chemist of the Corning Glass Works, received the John Price Wetherill Medal; Dr. *Cyril Stanley Smith,* professor of metallurgy and director of the Institute for the Study of Metals at the University of Chicago, received the Francis J. Clamer Medal for his work leading to the discovery of the basic factors in the metallurgical behavior of elemental plutonium.

United States Plywood Corp. has announced the election of *Raymond P. Fulwiler* as president of its subsidiary, Algoma Plywood and Veneer Co.

The death of *Leopold E. Block,* one of the founders of Inland Steel Co., has been announced.

The United Engineering and Foundry Co. announces the death of *Robert Harkness Ellis,* manager of the Electrical, Service and Construction Depts. since 1944.

William Ray Culbertson, a vice president of Rust Furnace Co., died recently after a long illness.

Allis-Chalmers Manufacturing Co. has announced the death of *Arthur K. Higgins,* an assistant director of research.

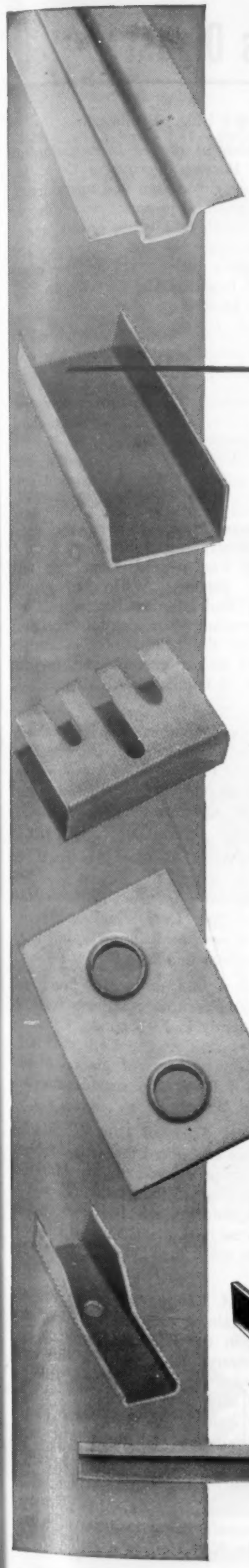
The recent death of *Joseph Minarik,* late president of the Abart Gear & Machine Co., has been announced.

Elizabeth Iron Works has announced the death of *Emil Schaeffer,* chief engineer and technical manager of the company.

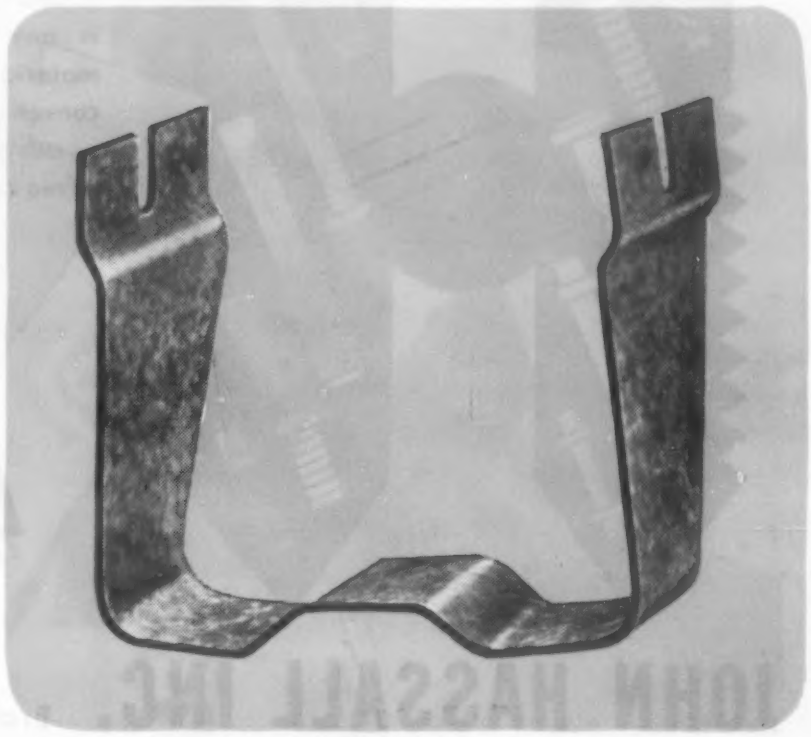
News of Companies

Scaife Co. recently celebrated its 150th anniversary. A simple program formally opened the new Sciafe office building in Oakmont, Pa.

Research Corp. has announced the opening of a new divisional office located



For Formed Shapes...



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in the Grant Bldg., Pittsburgh.

Announcement of the organization of the *High Vacuum Equipment Corp.* for the development, design and manufacture of high vacuum equipment was recently made by Joseph B. Merrill, president and general manager of the company. The general offices and factory of the company are located at 349 Lincoln St., Hingham, Mass.

J & S Tool Co., Inc. has announced an expansion program which includes a new plant at Livingston, N. J.

Announcement has been made of a new company formed to specialize in molded fiberglass materials handling trays. Known as the *Molded Fiberglass Tray Co.*, the new organization will be located in Lines-ville, Pa.

Aluminum Co. of America's Rockdale Works recently began production when aluminum was poured from the first operating potline. When completed, ALCOA's Rockdale installation will include a smelting plant with four potlines; a plant for the manufacture of carbon electrodes; and a power plant for the generation of required electricity.

Marvel Metal Products Co. has announced the formation of a new subsidiary company to be known as the *Randolph Metal Products Co.* The new company will operate out of its new facilities at 3834 W. 43rd St., Chicago.

Change of name incident to the formation of a new company has been announced by *Sub-Zero Products Co.* Previously known as *Sub-Zero Products Manufacturing Div., Deepfreeze Distributing Corp.*, the new company will be designated simply as Sub-Zero Products Co.

A modern and up-to-date brass and bronze ingot smelting plant was formally opened recently in El Segundo, Calif., by *H. Kramer & Co.* The California Div. is located on 23 acres of ground at 631 S. Aviation Blvd. and includes modern offices and laboratory.

Naugatuck Chemical Div., U. S. Rubber Co., has announced that it is doubling the production capacity of its Marvinol vinyl resin plant in Painesville, Ohio. The expansion program, which is expected to be completed by June, 1953, will lift production to more than 50,000,000 lbs annually.

Thomas A. Edison, Inc. has announced a college training program for laboratory assistants in the Edison Laboratory, the central research laboratory for the company. Under the new program, selected graduates of local high schools are currently in training, working days at the Edison Laboratory and going to evening classes at the Newark, N. J., College of Engineering.

Quaker State Metals Co. has purchased all the manufacturing facilities and business of the *New Holland Metals Co.* The

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new company will continue operations at Mountville, Pa.

Triangle Conduit & Cable Co., Inc. has entered the copper and brass tubing field with the construction of a new mill at New Brunswick, N. J. Completion of the plant is scheduled for May, 1953.

American Can Co. has announced that it has joined with other industrial corporations in support of the University of Chicago's Institute of Metals' basic research program. The contribution is at the rate of $20,000 per year.

The nation's supply of titanium is to get an extra boost, according to *Rem-Cru Titanium, Inc.*, who has announced that it has started expansion of facilities to more than double the company's ingot capacity. New melting facilities now being installed in the Rem-Cru plant at Midland, Pa., are scheduled for completion this year. Accordingly to the company, ingot sizes will be boost to a range of 2000 to 4000 lbs by the end of 1952.

Mill expansion to make possible an increase in production capacity by approximately 40% is underway at the *Carpenter Steel Co.'s Alloy Tube Div.* The proposed addition is to be complete and in production by the third quarter in 1953.

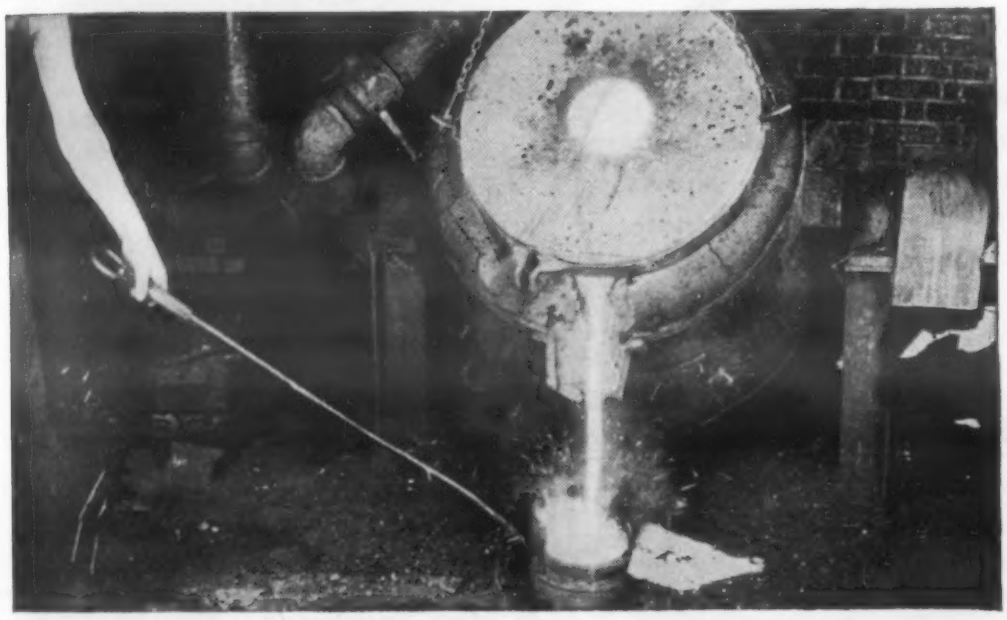
News of Societies

The formation of a task group concerned with metal cleaning processes for the automotive industry has been announced by J. C. Harris, chairman of the *American Society for Testing Materials* Committee D-12, on Soaps and Detergents. The function of the new task group, headed by H. A. Kafarski of Ford Motor Co., will be the development of recommendations of industry-wide standards for cleaning methods.

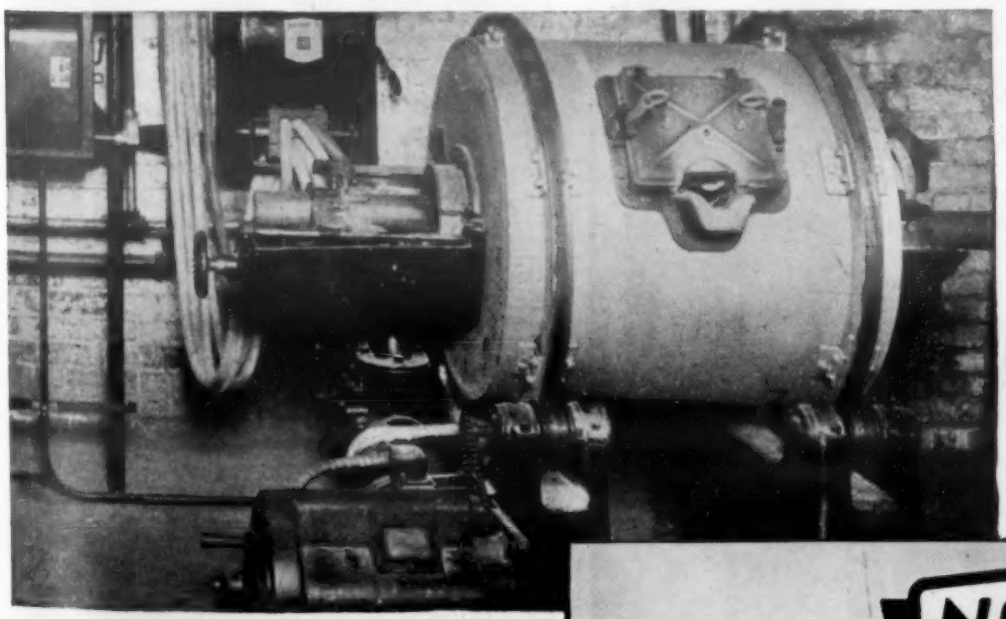
Announcement has been made by the *Resistance Welder Manufacturers Association* of their annual Prize Paper Contest which offers a total of $2250 in prizes for outstanding papers dealing with resistance welding subjects. The Contest offers an opportunity to those in industry or engaged in research laboratory work to compete for a first prize of $750, a second prize of $500, and a third prize of $250. Papers emanating from a university source (the author of which is either an instructor, graduate student or research fellow) are eligible to a $300 prize and a second prize in this classification of $200. Undergraduate students can submit papers for a $250 award. For complete details write to the *Resistance Welder Manufacturers Assn.*, 1900 Arch St., Philadelphia 3.

L. G. Hall, president of Stackpole Carbon Co., was elected president of the

THIS REVERBERATORY FURNACE is lined with a Norton CRYSTOLON* refractory cement, engineered to last longer on this particular metal-melting job.



THIS TILTING CRUCIBLE FURNACE has a cover and lining made of a Norton CRYSTOLON refractory cement. It was engineered to fit this firm's individual requirements.



THIS INDIRECT ARC FURNACE owes much of its high output to its lining, made of a custom-engineered Norton ALUNDUM* refractory cement.

Melt more metal per furnace-hour

with refractory linings engineered for you

Every time you interrupt your metal-melting campaigns to patch or replace your furnace linings, you lose production you never get back.

That's why just *any* refractory cement won't do. You want the *one* cement that fits your requirements so exactly that it reduces interruptions to a minimum. Chances are, the one just-right cement hasn't been made yet.

That's where your nearby Norton refractories engineer enters your picture. He's ready to call on Norton Research . . . pioneers for 40 years in the development of special refractories for complicated high-temperature requirements.

Working together, you and Norton Company are sure to arrive at the one CRYSTOLON, ALUNDUM, MAGNORITE* or FUSED STABILIZED ZIRCONIA refractory cement that fits your exact requirements.

For more information about this special Norton service, call your nearby Norton refractories engineer, or write Norton Company, 340 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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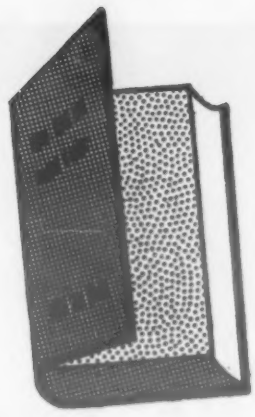
National Electrical Manufacturers Assn. at the annual meeting to succeed J. F. Lincoln, president of The Lincoln Electric Co. Vice presidents named were: Arthur A. Berard, president, Ward Leonard Electric Co.; J. L. Busey, vice president, General Electric Co.; J. W. Corey, president, The Reliance Electric & Engineering Co.; W. A. Elliott, president, Elliott Co.; Hoyt Post, executive vice president, Benjamin Electric Manufacturing Co. Elected as treasurer was A. F. Metz, president, The Okonite Co.

The first regular meeting of the newly formed *Operations Research Society of America,* organized by a group of leading scientists to promote the applications of scientific methods to business and military problems, was recently held at the National Bureau of Standards, Washington, D. C., Chairman of the November meeting was Dr. Jacinto Steinhardt of the Operations Evaluation Group of the U. S. Navy. Dr. Philip Morse, professor of physics at the Massachusetts Institute of Technology, is president of the ORSA which was formed in May, 1952.

Annual awards by the *Gray Iron Founder's Society* for contributions to the Gray Iron Foundry Industry were announced at the Society's 24th annual meeting, recently held in Cleveland. The awards were as follows: Gold Medal—C. R. Culling, president of Carondelet Foundry Co.; Citation—John A. Claussen, chief, Pig Iron Section, Iron and Steel Div., National Production Authority; Citation—James S. Vanick, research metallurgist, The International Nickel Co., Inc.; Citation—Edward B. Smith, vice president (retired) of American Brake Shoe Co.; Citation—A. J. McDonald, chief, ferrous casting section, Iron and Steel Div., NPA.

The Magnesium Assn. recently concluded its 2-day eighth annual meeting in New York. Registration, according to an Association report, established a new all-time high for the Association, totaling 475. A complete new slate of officers was elected for the coming year: Succeeding Mr. Winston as president is J. S. Kirkpatrick, director of research and development of Brooks and Perkins, Inc. W. C. Murray of Utica Radiator Corp. was elected vice president, and R. D. Taylor, Federated Metals Div., American Smelting and Refining Co., was elected treasurer.

The election of Frederick S. Blackall, Jr., president and treasurer of the Taft-Peirce Manufacturing Co., as president of *The American Society of Mechanical Engineers* for 1953, was announced at the Society's 73rd annual meeting in New York. The new president succeeds Reginald J. S. Pigott, chief engineer of the Gulf Research and Development Co. At the same meeting, Sir Geoffrey de Havilland, world-famous aircraft designer, was presented with the Daniel Guggenheim medal.



BOOK REVIEWS

Plastics

TECHNICAL DATA ON PLASTICS. *Published by Manufacturing Chemists' Association, Inc., Washington 5, D. C., 1952. Cloth, 8½ by 11 in., 184 pp. Price $2.50.*

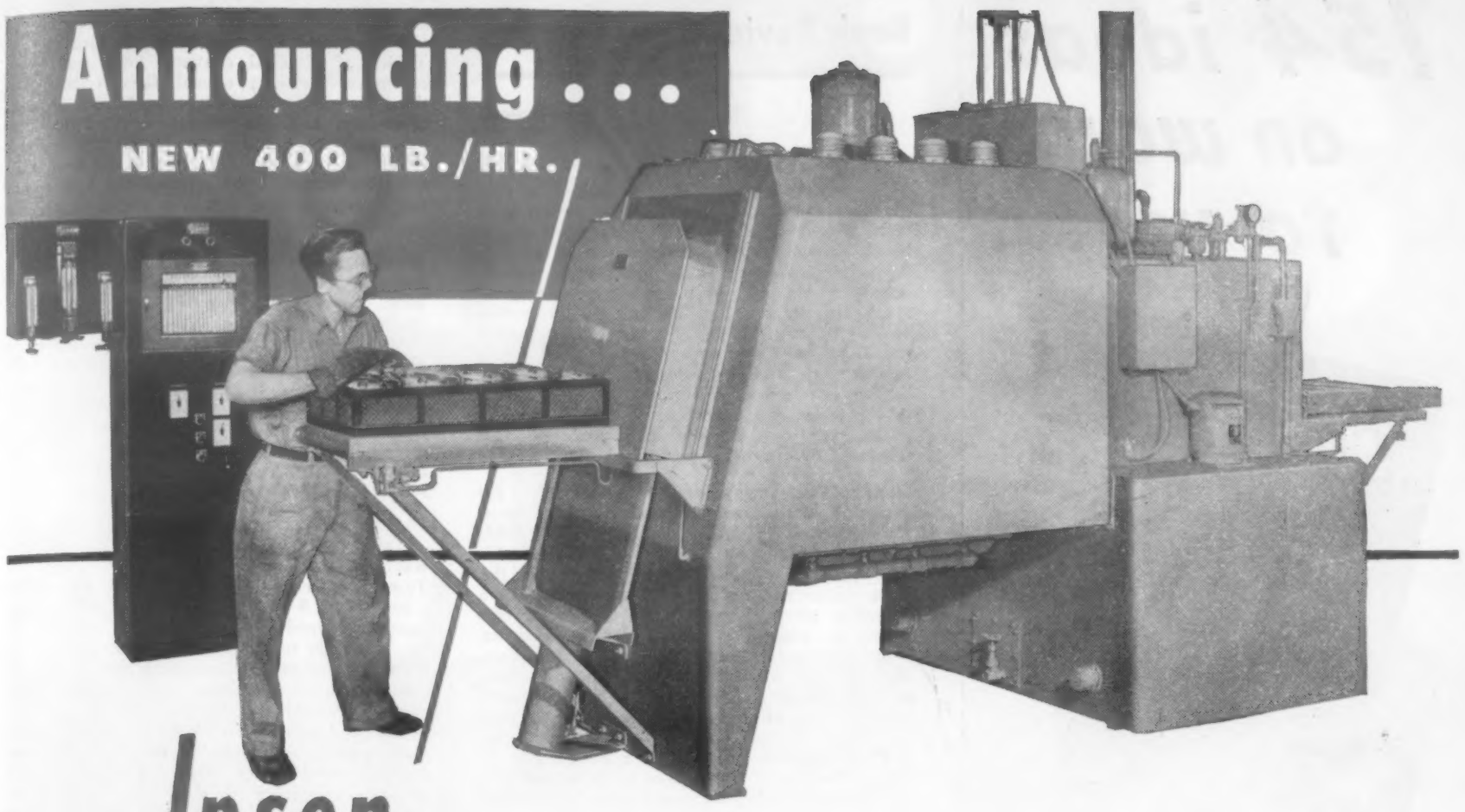
Here is a newly revised 4th edition of Technical Data on Plastics, an industry handbook which describes and catalogs properties of all commercially available plastics. This volume covers 24 types of plastic materials—three more than the last edition. It also contains two new sections which show properties of various plastics when made in the form of foams or thin films.

Materials for which data are published for the first time are alkyd and silicone molding compounds and epoxy resins. For each of the plastics discussed, the book offers descriptive information on general characteristics, along with graphical and tabular data on fabrication, durability, and electrical, mechanical and miscellaneous properties.

Information derived here has been compiled from tests made by manufacturers on their own materials, and in cases where test results differed, a range of values was selected. Test methods used in most cases were those established by the American Society for Testing Materials. A study of the introductory sections, tables, curves and test methods should give the user of plastics a good picture of the variety of properties offered by these materials and of the considerable range of compositions available in many of the individual groups.

Other New Books

ADHESIVES FOR WOOD. *By R. A. G. Knight. Published by Chemical Publishing Co., Inc., New York 10, N. Y., 1952. 242 pages. Price $5.00.* This book is designed to serve as a



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Book Reviews

(continued)

guide for the younger technician and to provide a ready reference for the experienced man. Plywood, veneering, durability of glues, blood albumin, casin glue, vegetable protein derivatives, phenol-formaldehyde, urea formaldehyde, polyvinyl and polyurethane adhesives, synthetic resin glue extenders, protection against fungal decay, preservatives, case hardening, aircraft, aging, soaking and mycological tests, and cyclical tests of wetting and drying are among the many topics covered. A comprehensive index, numerous references, a glossary of special terms and valuable tabulated data provide additional help.

NONFERROUS PHYSICAL METALLURGY. *By Robert J. Raudebaugh. Published by Pitman Publishing Corp., New York, N. Y., 1952. Cloth, 6 by 9 in.; 345 pages. Price $6.50.* The purpose of this book is to discuss the more important nonferrous metals from the aspect of physical metallurgy. Particular emphasis is placed on recent developments in their processing, fabrication and application. Melting and casting of reactive metals such as molybdenum; the direct casting of billets and slabs of aluminum, magnesium and copper alloys; the fabrication of ductile titanium; and the application of powder metallurgy to the production of nonferrous parts are among the developments discussed and illustrated here.

METAL INDUSTRY HANDBOOK AND DIRECTORY, 1952. *Published by Louis Cassier Co., Ltd., London, England, 1952. Paper, 9 by 6 in., 448 pages. Available only with the weekly journal "Metal Industry" at a combined annual subscription rate of $7.44.* This newly revised work is a recognized source of information and data for all who are engaged in the production and uses of nonferrous metals. Tables of physical contents have undergone extensive revision; official British Specifications for nonferrous alloys have been brought up-to-date, and the section devoted to Proprietary Alloys has been completely revised. Also, the Directory for Buyers has been considerably enlarged to facilitate the locating of suppliers of plants for, and products of, the nonferrous metals industry.

WELDABILITY OF METALS. *Published by The Lincoln Electric Co., Cleveland 17, Ohio, 1952. Paper, 6 by 9 in., 141 pp. Price 50¢.* Reprinted from the 9th Edition of the "Procedure Handbook of Arc Welding Design and Practice", the material presented here discusses factors determining weldability; causes and cures for hard to weld metals; welding procedures for steels, nickel, iron, alloys, copper, aluminum and hardfacing. Complete tabular data, drawings and pictures supplement the text.

50-YEAR INDEX TO AMERICAN SOCIETY FOR TESTING MATERIALS TECHNICAL PAPERS AND REPORTS. *Published by American Society for Testing Materials, Philadelphia 3, Pa., 1952. Cloth, 6 by 9 in., 216 pp. Price $6.00.* This Index is intended to make readily available to the materials technologist, the researcher, the librarian, and all others concerned with the fields covered, pertinent information on a particular subject. It provides a detailed author and subject index to all ASTM technical papers and reports dealing with materials, particularly their properties and testing, appearing in ASTM publications covering the period from 1898 through 1950. In addition, a number of technical reports have been referenced which, while not credited to a specific author, nevertheless provide worthwhile data and information which should be considered when searching the available data in ASTM publications on a specific subject. Many of these reports are the result of cooperative effort in technical committees.